EOS, Transactions, American Geophysical Union Vol. 64, No. 2, Pages 9 – 16 January 11, 1983

Tectonophysics

8130 Plate Tectonics
A CAPTURED ISLAND CHAIN IN THE COAST RANGE, OREGON AND WASHINGTON
R. A. Duncan (School of Oceanography, Oregon State University, Corvallis, Oregon, 97331)

K-Ar and ^{40}Ar-^{39}Ar geochronologic data reveal the Paleocene to Eocene eruptive history of volcanic centers which produced the basaltic basement rocks of the Coast Range of Oregon and Washington. Volcanism was short lived at each center and migrated with time from the northern and southern ends toward the center, near the present mouth of the Columbia River. A plot of crystallization ages against geographic location produces a distinct V-shaped pattern. An origin by hot spot volcanism centered on or near a spreading ridge in early Tertiary time best explains the observed age distribution. Limited geochemical data support this model, as the basalts exhibit attributes of both spreading ridge and hot spot-related volcanism. Icelandic volcanism may be a present- day analog. Absolute motion modeling shows that the Yellowstone hot spot could have generated an island chain with approximately the correct paleoazimuth and volcanic propagation rate. Shortly after formation, this oceanic volcanic lineament collided with North America and rotated into its present marginal setting. The western edge of North America subsequently crossed over the hot spot, perhaps triggering late Eocene to Oligocene volcanism in the Coast Range, the Miocene Columbia River basalts in eastern Washington and Oregon and most recently, the basalts of the Snake River Plain and the Yellowstone area.
J. Geophys. Res., Red, Paper 2B1537

8150 Plate Tectonics
COLLISION PROCESSES IN THE NORTHERN MOLUCCA SEA
Gregory F. Moore (Cities Service Co., ERG Research, P.O. Box 3908, Tulsa, OK 74102), Eli A. Silver

The Mindanao-Molucca Sea region is a collision zone between two facing island arc systems. The west Mindanao Arc, which was active from the Cretaceous through the Quaternary, apparently collided in the mid-Tertiary with the east Mindanao Arc, which was active from the Cretaceous through the Oligocene. Following the collision in the Miocene, the Agusan-Davao Trough was filled with coarse clastic sediments. The ophiolite terrane exposed in the Pujada Peninsula was probably emplaced during this collision.

In the Molucca Sea region, the collision between the Halmahera Arc and the Sangihe Arc is still active. Gravity data and seismic reflection profiles indicate a crustal break between the Talaud Ridge and southern Mindanao. The deformed rocks of the Talaud Islands probably represent the northern limit of the forearc terrane of the Halmahera Arc system. The East Sangihe and West Halmahera thrusts can be followed in seismic reflection data northward to the latitude of Talaud. The origin of the Snellius Ridge complex remains obscure, but we interpret it to be the northern extension of the Halmahera Arc terrane.

A tectonic reconstruction for this complex region proposes that the collision in the Mindanao region occurred between two intra-oceanic arc terranes with very little intervening sediment. The southern end of the eastern Mindanao Arc was connected with the northern end of the Halmahera Arc by a transform fault. We suggest that the thick sediments presently being deformed in the Molucca Sea collision zone were eroded from New Guinea and Halmahera in the south and from the collision zone in Mindanao. A substantial amount of strike-slip motion has probably occurred during the collision in Mindanao. In response to the collision, two new subduction zones, at the Cotabato and Philippine Trenches, are propagating southward.
Geophys. Monogr. Ser., vol. 27, AGU
Paper 026012

8150 Plate tectonics
LATERAL STRETCHING OF THE PHILIPPINE SEA PLATE SUBDUCTING ALONG THE NANKAI-SURUGA TROUGH
M. Ukawa (National Research Center for Disaster Prevention, Niiharigun, Ibaraki 305, Japan)

Focal mechanisms are investigated for shallow earthquakes ($h \leq 60$ km) of central Japan by using telemetered seismic data of microearthquakes. Shallow earthquakes in central and southwestern Japan can be distinguished into three groups, upper crustal earthquakes, subcrustal earthquakes and interplate thrust earthquakes, the first and the second ones being subjects of the present study. Most of the upper crustal earthquakes are of strike slip type or reverse faulting with E-W to SE-NW compression, whereas the subcrustal earthquakes are characterized by strike slip or normal faulting with E-W to NE-SW extension. The subcrustal seismic zone, subparallel to the Nankai trough, becomes progressively deeper landward to the north and progressively shallower to the east so that it emerges into a very shallow seismic activity in the Izu Peninsula which has been interpreted as a microcontinent of the Philippine Sea plate colliding against the Eurasian plate. On the basis of hypocentral distribution, three dimensional seismic velocity structure, and focal mechanisms, subcrustal earthquakes are considered to occur within the subducting Philippine Sea plate that extends down to a depth of at least 60 km. On the basis of this and other focal mechanism studies, stress trajectories are drawn for the subducting Philippine Sea plate and for the overriding Eurasian plate. The overriding plate is, on the whole, under the E-W compression which coincides with the moving direction of the Pacific plate relative to the Eurasian plate. The subducting plate, on the other hand, is under lateral extension along its strike. We interpret that the latter is a stress regime unique to an incipient subduction zone, where the subducting plate at subcrustal depths is forced to warp downward, being constrained laterally at the arc-arc junctions, and thereby comes under lateral stretching. The lateral constraints arise either from apparent increase in flexural strength of the plate at the arc-arc junction or from buoyancy of a microcontinent that resists subduction. (Philippine Sea plate, focal mechanism, stress trajectories).
Tectonics, Paper 2T1410

8150 Plate Tectonics
PALEOMAGNETISM AND AGE DETERMINATION OF CRETACEOUS ROCKS FROM GYEONGSANG BASIN, KOREAN PENINSULA
Y. Otofuji (Department of Geology and Mineralogy, Kyoto University, Kyoto 606, Japan), J. Y. Oh, T. Hirajima, K. D. Min and S. Sasajima

Relative motions between the Korean Peninsula and the Asian continent were studied for the period since the Cretaceous. The K-Ar age of 68.1 ± 3.4 Ma for basalts from Hagbong Volcanic Member confirms the Cretaceous period of Gyeongsang Supergroup. Paleomagnetic directions of samples of sediments and lavas from Gyeongsang Basin are fairly grouped with a mean confidence intervals of declination = 26.6°, inclination = 62.3° and α_{95} = 8.3°. The reliability of the direction is ascertained through thermal and alternating field demagnetization techniques and comparison of the remanent directions of sedimentary rocks and a lava flow. The obtained South Korea pole (131°E, 69°N) is in excellent agreement with the poles from neighboring regions of North Korea, China, Kolyma and the Siberian Platform. From this concordance it is concluded that since the late Cretaceous the Korean Peninsula has been a part of the Asian continent and was not subjected to any tectonic rotation relative to the Asian continent. This high stability of the Korean Peninsula against tectonic disturbances is explained by the presence of a thick and stiff lid within lithosphere, inferred from the comparison between the thickness of the lithosphere beneath the Korean Peninsula and Japan Island. (Paleomagnetism, Korean Peninsula, Cretaceous).
Geophys. Monogr. Ser., vol. 27, AGU
Paper 026013

8150 Tectonophysics (Plate Tectonics)
CRUSTAL STRUCTURE OF A SHORT LENGTH TRANSFORM FAULT IN THE CENTRAL MARIANA TROUGH
J. B. Sinton (Conoco Inc., P. O. Box 1267, Ponca City, Oklahoma 74601) and D. M. Hussong

The crustal structure of the Pagan Fracture Zone, a short length transform fault system in the central Mariana Trough was determined from a detailed seismic refraction study using ocean bottom seismometers. The Mariana Trough is a back-arc basin with a spreading center opening at a half rate of less than 2 cm/yr. Interpretation of both the seismic travel times and amplitudes suggest that the crust within the transform valley is 1 to 1.5 km thinner than oceanic crust generated at slow spreading centers away from transform faults, but is thicker than fracture zone crust in longer transform offset systems. The crustal differences can be accounted for solely by thickening, relative to longer transforms, of the lower crust by as much as 3.0 km. Other major differences between the Pagan short transform system and transform systems of greater length are: (1) the transition from Pagan transform crust to oceanic crust is only 2.0 to 4.0 km wide compared to 5 to 10 km for longer transforms, (2) the 30 mgal free air gravity anomaly over the Pagan transform valley is half that of longer transforms, and (3) whereas bathymetric ridges parallel to longer transform systems are underlain by high density material, the entire valley of the Pagan transform system is underlain by high density material. These differences can be explained by the different thermal properties of the third wall at the spreading center/transform intersections, and its affect on crustal accretion. As the third wall becomes colder, the crust becomes thinner, the free air gravity anomaly is larger, the transition from transform to oceanic crust is wider, and the bathymetric relief across the valley is greater. No significant difference was observed between crustal structure in the transform zone compared to the fracture zone portion of the Pagan transform system. (Plate tectonics, transform faults, crustal structure, accretion).
Geophys. Monogr. Ser., vol. 27, AGU
Paper 026021

8150 Plate Tectonics
HYPOTHETICAL MODEL FOR THE BENDING OF THE MARIANA ARC
Robert McCabe (Department of Geological Sciences, University of California, Santa Barbara, California 93106) and Seiya Uyeda.

The southern Mariana Arc has a distinct eastward convex shape which is more pronounced than the typical arcuate structure observed above oceanic subduction zones. The Yap Trench is offset hundreds of kilometers westward from the main Izu-Bonin-Mariana trend. Between the southern Mariana Arc and the Yap Trench, the Mariana Arc has an anomalous east-west orientation and is characterized by a markedly lower seismicity than the main Mariana trend. Situated east of the Yap Trench is the ESE trending Caroline Ridge that geochemically resembles the Hawaiian hot spot trend. Paleomagnetic data from Truk and the overall eastward younging trend of the Caroline Ridge suggest that the Caroline Ridge is part of the Pacific Plate as suggested by Clague and Jarrard (1973). Pacific Plate motion for the Caroline Ridge predicts that the ridge has collided with the Yap Trench during the Tertiary. Other evidence for this collision is observed on the island of Yap and by the fact that this portion of the arc has not had volcanic activity during the Neogene period. Paleomagnetic studies show that since the early Oligocene, Guam has rotated greater than 50° clockwise. During this same period, Saipan has rotated only 3° clockwise. This data, the similar bend of the West Mariana Ridge and the Mariana Ridge, and the orientation of fold axes on Guam and Saipan suggest that the clockwise rotation occurred after the initiation of spreading of the Parece Vela Basin and before the opening of the Mariana Trough. This investigation also suggests that the east-west trending portion of the [illegible] is a transform boundary which developed [illegible] the collision. [illegible]
Geophys. Monogr. Ser., vol. 27, AGU
Paper 026020

News

NSF Directors Asked to Resign

Edward A. Knapp, the Reagan administration's appointee to replace former NSF Director John Slaughter, who left the post to become chancellor of the University of Maryland, has asked for, and received, the resignation of Deputy Director Donald N. Langenberg. Knapp has also requested the resignations of Assistant Directors Francis S. Johnson (astronomical, atmosphere, earth, and ocean sciences) and Eloise E. Clark (biological, behavioral, and social sciences). This leaves only one post at the top management levels of NSF: the assistant director for mathematics and physical sciences—a post held, until Slaughter's resignation, by Knapp. The new director is the only one of the former top managers remaining; no assistant directors have yet been named.

On the surface the management changes appear to be a bit fast, a 'clean sweep,' as it were. Knapp is a former Los Alamos associate of President Reagan's science advisor, George Keyworth II. Further, Knapp's name was not on any of the lists of directorial candidates proposed by the National Science Board. Normally, NSF directors are chosen, more or less apolitically, for their abilities as scientists, not necessarily as managers. Knapp had been at Los Alamos for 24 years before joining NSF a few months ago. He came from a job as head of the Accelerator Technology Division. Thus, the picture at the NSF may look to the casual observer as a 'shake-up' of sorts.

For a few days after the announcements the rumblings could be heard throughout the ranks of middle and lower management at NSF. At the National Science Board, which governs and advises NSF activities, Chairman Lewis M. Branscomb said, 'I fear the manner in which these personnel decisions were made and announced will exacerbate our ability to find highly qualified candidates who will accept' (*Science*, Dec. 24, 1982).

But, Branscomb also acknowledged that the new director should be able to select his staff. The director, deputy director, and assistant director positions at NSF are customarily filled by presidential appointment, and it would be premature to judge the political motivation before the posts have been filled. Furthermore, in every instance, except perhaps in the case of Eloise Clark, who will remain at NSF for a while, there were mitigating circumstances affecting the resignations. Donald Langenberg is to become the Chancellor of the University of Illinois, Chicago campus. Geophysicist Francis Johnson had already made it known that he was returning to the University of Texas at Dallas.

For the present the NSF budget has not been subjected to overall reductions; NSF got its appropriations this year and did not have to await a congressional continuing resolution. According to Branscomb, '. . . the President has apparently given high priority to NSF . . .' (*Science*, Sup.), and the next fiscal year budget may be increased, even in the area of the social sciences. Feelings within the earth sciences community range from hesitation to disquiet, because the specifics and priorities for future NSF programs remain in question. After all, the National Science Foundation is not set up to manage science; projects supported by NSF funds are, for the most part, unsolicited research proposals. According to a recent discussion of the Reagan administration's position with regard to the NSF, however: 'The Presidential Personnel Office, the White House unit responsible for presidential appointments, has long wanted Reagan apprentices in the Foundation and applied pressure on Knapp to request the resignations,' (*Science*, sup.). In another published report it was stated that 'A chief concern is that it (the removal of all apparent assistant directors) will make NSF more subject to the political whims of future administrations,' (*Chem. Eng. News*, Dec. 20, 1982).

Recently, at the 20th anniversary of SLAC (Stanford Linear Accelerator Facility), Presidential Science Advisor Keyworth gave his views of what he described as a major problem to be overcome; that is, the attitude of the American scientific community. According to a report of his comments (*Indust. Res. Develop.*, Dec. 1982): 'Our result of the abundant Federal funding of past decades . . . (argued Keyworth) . . . is the feeling among researchers that they need not pay attention to the profit incentive. . . . The cornucopia of 1960's science plainly is gone forever; the new order, even in basic research, involves a truly hardnosed evaluation of the real value of individual projects.' In the same report, however, George Keyworth was quoted as saying that the United States has 'The strongest basic research enterprise that the world has ever known . . . a resource of such importance that there's no question about our high priority to protect and maintain it' (*Indust. Res. Develop*, sup.).—*PMB*

Tapping the Magnetosphere

Scientists may have found a way to tap the earth's magnetosphere to help power global communications. A team of scientists and engineers from Lockheed's Palo Alto Research Laboratory, from Stanford University, and from the U.S. Office of Naval Research reported at the recent AGU Fall Meeting/ASLO Winter Meeting that they have confirmed a long-held theory that man-made very low frequency (VLF) radio waves move along the earth's magnetic field lines to great altitudes within the magnetosphere and dislodge electrons into the ionosphere. The confirmation of the theory aids in the understanding of communication disturbances caused by increased sunspot activity and broadens the potential for advancement in new forms of radio communication.

The magnetosphere is the region of space where the earth's geomagnetic field is confined by the solar wind. The ionosphere, closer to the earth than the magnetosphere, is that part of the earth's atmosphere that contains free, electrically charged particles.

Radio communication could be improved by using magnetic field lines to capture and amplify VLF radio waves 30–40 dB—more than 1000 times—by using energy drained from electrons precipitated from the earth's radiation belts into the ionosphere, according to Joseph B. Reagan, manager of the Lockheed Space Sciences Laboratory. VLF communication uses radio waves with long wavelengths that travel across large portions of the earth.

The process of dumping electrons from the earth's radiation belts into the upper ionosphere occurs constantly. The earth's near-space environment is a complex equilibrium of inputs, primarily from the sun, and losses, which occur as electrons are drizzled out of the radiation belts. This drizzling can be caused both by natural events and by transmitters on earth. However, the magnitude of the human-induced effect was unknown until Reagan's team successfully linked the effect of electron precipitation directly to an earth transmitter. It is possible, Reagan estimated, that under some conditions high-power transmitters induce half of the electron precipitation.

For many years it has been known that transmissions from high-power sources could penetrate through the ionosphere and leak into the magnetosphere, interacting with the electrons along the Van Allen belts. However, the waves of these transmissions can be amplified, resulting in an alteration of the pitch angle of the electrons and thus the precipitation of electrons from the magnetospheric field lines. Until the present experiment, dubbed SEEP for Stimulated Emission of Energetic Particles, this cause and effect had not been definitively shown.

SEEP scientists employed three Navy VLF transmitters and one operated by Stanford in Siple, Antarctica, to send a predetermined pattern of signals—3 seconds on, 2 seconds off—into the magnetosphere. The signal pattern traveled along the earth's field lines and were then 'duplicated in the form of electrons entering the ionosphere over a region several hundred miles long,' Reagan said. 'When these freed electrons enter the ionosphere, they create a miniature aurora borealis—small light emissions—that can be detected by an airglow photometer,' Reagan noted. 'In addition, X rays are released that can be picked up by a mapping X ray spectrometer.'

Reagan said that ongoing magnetospheric research will 'help us better understand the physics of the magnetosphere and the ebb and flow of the radiation belts. When we fully understand this process, there is the potential of expanding communications into the region.'

IAHS Notes

Nominations from national committees and commissions for the International Association of Hydrological Sciences (IAHS) elections—to be held in Hamburg, F.R.G., during the XVIII General Assembly of the International Union of Geodesy and Geophysics, August 15–27, 1983—should be submitted as soon as possible to J. C. I. Dooge, Department of Civil Engineering, University College, Upper Merion Street, Dublin 2, Ireland. Dooge is chairman of the IAHS nominations panel. Others on the panel are Dr. Bogoiavlensky, N. B. Ayibotele, Dr. Rodier, and Mark Meier.

In addition, nominations from national committees for the 1983 International Hydrology Prize will be open until April 1. Nominations should contain a statement (up to 1000 words) describing the qualifications and merits of the candidate. By definition, candidates should have made an outstanding contribution to the advancement of hydrology. Send nominations to IAHS Secretary General John C. Rodda, Institutes of Hydrology, Wallingford, Oxon OX10 8BB, UK.

The working group on the IAHS reorganization, chaired by G. Kovács, produced a draft report that was discussed at the July 1982 IAHS First Scientific General Assembly at Exeter. As a result of those discussions in commissions, in the IAHS bureau, and in the IAHS plenary sessions, proposals will be made at the Hamburg meeting to amend the IAHS statutes and bylaws. In accordance with the existing statutes and bylaws, details of the proposed changes are contained in the December issue of the *IAHS Newsletter*.

Geophysicists

Murray J. Baron became the director of the EISCAT (European Incoherent Scatter) Scientific Association this past fall. He is on leave of absence from SRI International, which is based in Menlo Park, Calif. The former EISCAT director, ***Tor Hagfors***, has assumed the position of director of the National Atmospheric and Ionospheric Center (NAIC) at Cornell University. ***Jürgen Röttger***, of the Max Planck Institute for Aeronomy, has been appointed EISCAT associate director.

Cinna Lomnitz, professor of seismology at the National University of Mexico and a member of the Instituto de Investigaciones en Matematicas Aplicadas y en Sistemas, has been appointed corresponding member of the Academy of Sciences of Chile. He is a member of the Mexico Academy of Sciences.

Hans A. Panofsky, an AGU Life Fellow, retired September 1 as Evan Pugh Professor Emeritus of Atmospheric Sciences at The Pennsylvania State University. Contributions are invited to the Hans A. Panofsky Scholarship Fund, established at Penn State to provide scholarships for outstanding students in meteorology. Checks payable to The Pennsylvania State University and designated to the Panofsky Fund may be sent to the Office of Gifts and Endowments, Old Main, University Park, PA 16802.

Books

The Properties of Groundwater

G. Matthess, Wiley-Interscience, New York, xii + 406 pp., 1982, $45.95.

Reviewed by Frank T. Caruccio

Scientists and engineers concerned with the environmental aspects of groundwater frequently require a comprehensive reference text that provides an overview of the pertinent problem, appropriate decision making criteria and a guide to relevant references. *The Properties of Groundwater*, translated from the German by John C. Harvey, is a welcome addition to the select books currently available in this field. The book occupies the niche that lies between Hem's classic *Study and Interpretation of the Chemical Characteristics of Natural Water* (U.S.G.S., *Water Supply Pap. 1473*, 363, pp., 1970), Stumm and Morgan's *Aquatic Chemistry* (John Wiley, New York, 780 pp., 1970), and Freeze and Cherry's *Groundwater* (Prentice-Hall, Englewood Cliffs, N.J., 604 pp., 1979). The level of presentation, coupled with the cost, may limit the use of the book to advanced seminar courses and, more appropriately, as a solid reference text for scientists and researchers concerned with water and water quality. The table of contents is well indexed and is structured to allow the reader to review effectively the subject matter.

The book is divided into four sections. In the first section, the physical and geochemical nature of water is reviewed as well as the physical chemistry of solutions and mineral equilibria. Matthess pays particular attention to near-surface geochemical processes and relates soil-gas composition to groundwater quality. A background in geochemistry, although not necessary, would facilitate the comprehension of the material presented.

The second chapter emphasizes rock-water interactions and the chemical factors affecting the distribution, nature, and concentration of various chemical and ionic species. The author presents material gleaned from a variety of sources within the context and framework of an interrelated atmospheric-rock composition-biologic processes model and discusses the roles of the relevant parameters in water quality determinations. The various biologic processes operating in the soil-near surface environment are shown to influence ground gas composition, which in turn is related to the causal water quality controls. One gains an appreciation of the degree to which a mature soil profile, and its associated microbiologic community, affects the ultimate groundwater chemistry. Researchers concerned with the reclamation of disturbed lands would find this section (and the beginning of chapter 3) most useful in understanding the various interrelationships afforded by the near-surface biologic processes, the importance of vegetation in the total reclamation procedure, and the direct and indirect effects of organic matter on water quality. Matthess provides the reader with a refreshing insight into these near-surface processes and the important role they play in affecting water chemistry. Throughout, the author uses numerous relevant case histories to illustrate the pertinent water quality variations and mechanisms of control. The chapter concludes with a good overview of the man-made factors that affect water quality that range from the indirect effects of changes in the composition of the atmosphere to the direct effects of discharging organic and radioactive wastes to the environment.

In the next chapter, the origins and occurrence of groundwater are discussed, beginning with precipitation quality variations, percolation water chemistry, and continuing with an excellent overview of the hydrochemical mechanisms responsible for the numerous water quality variations. A variety of major, minor, and trace element constituents are discussed in terms of their natural occurrence and the factors that control their levels of concentration.

A relatively brief attempt is made to characterize groundwater quality in terms of the chemistry of the aquifer. Understandably, the author restricts his attempts to broad generalizations and confines categories to regional hydrogeologic units. Nevertheless, distinctions between the water quality variations are related to the aquifer materials and provide the reader with a starting point from which to seek additional information.

The final chapter, dealing with the classification of groundwater and methods of presenting data, is an excellent and complete review of the various techniques available to perform these functions. A wide range of pictorial and multivariate diagrams are discussed and illustrated to provide the reader with an appreciation of the strengths and weaknesses of the various methods of depicting water quality data and classifying groundwater. Following, water classification schemes based on origin, dissolved constituents, and potential use are presented and are reviewed in terms of applicability for a particular use. Errors in maximum permissible concentrations for some dissolved constituents in potable water could have been avoided by using more re-

cent U.S. drinking water standards (the author cites the 1962 standards, which have undergone several revisions). These minor points aside, this chapter contains a comprehensive and thorough discussion of methods used to illustrate and group water quality data into meaningful classifications.

One major advantage this book has over its American counterparts is the degree to which foreign literature is cited and used in the discussions. Of the approximately 935 references, more than half are foreign. Thus, in addition to an exposure to the studies reported in the foreign literature, the reader gains an appreciation of how the European school discerns the causal effects of water quality variations.

Upon this blend of an American and European information base, Matthess develops some interesting and novel insights into the properties of groundwater. This book is recommended as an addition to your library of reference texts.

Frank T. Caruccio is with the Department of Geology, University of South Carolina, Columbia, S.C.

Scientific Basis for Nuclear Waste Management

J. G. Moore (ed.), vol. 3, Plenum, New York, xvii + 632 pp., 1981, $49.50.

Reviewed by Newell J. Trask

As a result of the Reagan administration's commitment to nuclear energy as a significant future energy source and of attempts by the 97th Congress to grapple with legislative aspects of the problem, increased attention has focused recently on the problem of safely disposing of nuclear waste. These proceedings of the Third Symposium on Nuclear Waste Management of the Materials Research Society provide insight into the status of investigations on the subject as of late 1980. As with volumes 1 and 2 of this series, the 77 contributions are all short progress reports of ongoing research with the emphasis fittingly on materials science. Readers who wish extensive background material on the problems of nuclear-waste management and disposal, details of specific sites, or overviews of the programs of research in this country and abroad will have to look elsewhere.

The prevailing strategy for waste disposal in mined repositories in most countries uses a system of independent barriers that block or resist the migration of radionuclides away from the repository. The principal barriers are a waste package, a conservatively designed repository, and a geologic environment conducive to waste isolation. In terms of potential processes, the main ones taking place within the three barriers are (1) leaching of the waste and reaction with fluids which penetrate the waste package; (2) reaction, precipitation, or solution of radionuclides with ambient waters and minerals at initially elevated temperatures; and (3) transport with attendant interaction along hydrologic flow paths at low concentrations and temperatures in the far field, respectively.

These proceedings devote the most space to the first line of defense: the waste form and the reactions it may undergo in its immediate vicinity. In addition to physical descriptions of waste forms and production processes, there are sections on leaching, radiation effects, and natural analogues. Both commercial and defense high level waste are included, and there is a section on non-high-level waste. Within the category of high-level waste, borosilicate glass and alternative waste forms, including spent fuel, receive approximately equal treatment.

Compared with the earlier volumes, these proceedings devote increased space to the mechanisms of waste-form leaching. Several papers describe highly sophisticated surface and near-surface analytical techniques being used to study the reaction layer that forms on the solid waste during exposure to an aqueous environment. Much remains to be learned about these mechanisms, especially at elevated temperatures and in the presence of additional phases used for canisters or overpacks. A series of papers describes a variety of metallic, ceramic, and polymeric materials under consideration for use as waste containers; other papers discuss the possible use of clays, zeolites, and other materials as backfill. The effects of prolonged radiation doses on a variety of glasses and minerals are also explored, but firm conclusions about these effects are not yet possible.

The diversity and complexity of the research reports reemphasize how difficult it is to simulate the functioning of an underground radioactive-waste repository for time periods of thousands of years. Decision-makers must rely on simplified but conservative models of repository performance reported on in other publications. These models predict environmental impacts from decommissioned repositories well within acceptable limits. In situ tests of repository functions at actual sites, operating experience, and continued laboratory and theoretical work such as that reported in these proceedings are needed to ensure that model calculations are reasonable and that no significant phenomena have been overlooked.

Newell J. Trask is with the U.S. Geological Survey, Reston, Virginia.

New Publications

Items listed in New Publications can be ordered directly from the publisher; they are not available through AGU.

Advances in Hydroscience, vol. 13, V. T. Chow (Ed.), Academic, New York, xi + 393 pp., 1982, $53.00.

Boundary Element Methods in Solid Mechanics, S. L. Crouch and A. M. Starfield, George Allen & Unwin, Boston, Mass., xii + 322 pp., 1983, $30.00.

The Boundary Integral Equation Method for Porous Media Flow, J. A. Liggett and P. L.-F. Liu, George Allen & Unwin, Boston, Mass., xi + 255 pp., 1983, $35.00.

Circulation in the Coastal Ocean, G. T. Csanady, *Environ. Fluid Mech.*, D. Reidel, Hingham, Mass., xi + 279 pp., 1982, $52.50.

Comparative Crystal Chemistry, R. M. Hazen and L. W. Finger, Wiley-Interscience, New York, xv + 231 pp., 1982, $43.95.

Geophysical Mapping of Buried Precambrian Rocks in the Cloncurry Area, Northwest Queensland, A. J. Mutton and R. A. Almond, *Rep. 210, BMR Microform MF95*, Bureau of Mineral Resources, Canberra City, A.C.T., Australia.

Migration of Geophysical Data, E. A. Robinson, International Human Resources Development Corp., Boston, Mass., x + 208 pp., $34.00.

Mount St. Helens Eruptions of 1980: Atmospheric Effects and Potential Climatic Impact, R. E. Newell and A. Deepak (eds.), NASA, Washington, D.C., xxvi + 119 pp., 1982, $6.00. Order from Department 36-F, Superintendent of Documents, Washington, D.C. 20402; refer to stock number 033-000-00857-1.

Nor Any Drop to Drink, W. Ashworth, Summit, New York, 272 pp., 1982, $6.95.

Petrology of the Ocean Floor, R. Hekinian, *Oceanogr. Ser.*, vol. 33, Elsevier, New York, xiv + 393 pp., 1982, $93.00.

Physical Properties of Crystals, J. F. Nye, Oxford University Press, New York, xiii + 322 pp., 1979.

Pulse Coding in Seismology, ~~M. L. Barbour~~, International Human Resources Development Corp., Boston, Mass., vi + 89 pp., 1982.

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Qualified persons should submit a resume, names of 3 references, and a statement of research interests to Robert J. Stanton, Head, Department of Geology, Texas A&M University, College Station, Texas 77843.

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University of Kentucky/Department of Geology. The Department of Geology invites applications for two tenured track Assistant Professor level positions. Both appointments are for soft rock geologists preferably with some experience in industry and interests including one of the following: sedimentology, stratigraphy, carbonate petrology, organic geochemistry, or isotope geology. The successful applicants would be required to participate in active research, supervise graduate students and teach graduates and undergraduates. Familiarity with quantitative techniques is desired; Department has access to a variety of computational devices. Academic vitae and names of three references should be sent to Dr. Lyle Sendlein, Chairman, Search Committee, 321 Patterson Office Tower, University of Kentucky, Lexington, Kentucky 40506-0027. Closing date is March 1, 1983. Both appointments are to commence in August 1983, but an earlier date may be considered. Salary is negotiable.

The University of Kentucky is an equal opportunity/affirmative action employer.

Postdoctoral Positions in Planetary Studies. The Laboratory for Atmospheric and Space Physics at the University of Colorado has openings for two postdoctoral appointments. One appointment will be for study of Voyager observations of planetary rings. The other appointment will be in the field of planetary atmospheres: aeronomy, radiative transfer, and cloud chemistry and microphysics. The Laboratory for Atmospheric and Space Physics is involved with the acquisition, analysis, and understanding of spacecraft observations of solar system objects. Current active missions include Voyager, Pioneer Venus, and Galileo. Applications are invited from graduating students and recent graduates with experience in one or more of the above areas. The term of appointment is for one year with possible renewal on a yearly basis; the starting salary is approximately $1900 per month.

Send letter of application, resume and names of two references by April 15, 1983 to:

Prof. C. A. Barth
Laboratory for Atmospheric and Space Physics
Campus Box 392
University of Colorado
Boulder, CO 80309

The University of Colorado is an equal opportunity/affirmative action employer.

Department Head/Texas A&M University. The Department of Geology is engaged in a nationwide search for a new Department Head with the anticipated starting date being September 1, 1983. The position is open as to salary, rank and area of interest. We are seeking a person with a national or international reputation in the geological sciences who would take over the leadership of our research and teaching oriented department.

Our faculty currently numbers twenty three and will increase by three by the Fall of 1983. Construction started in January, 1983 on a 60,000 square foot addition to the Halbouty Geosciences Building. We currently have an undergraduate enrollment of over 400 students and there are about 130 students in our graduate (M.S. and Ph.D.) program. The Department of Geology is in the College of Geosciences (Dean Gordon P. Eaton) along with the Departments of Geophysics, Oceanography, Meteorology and Geography. The traditional strengths of the department are in the areas of stratigraphy, sedimentation, paleontology, structure-tectonophysics and engineering geosciences. Our strong ties with industry are reflected in the level of financial support and jobs for our students. If you would like to be considered for this position, please submit a recent resume along with the names of at least three persons who are willing to write letters of recommendation. Send Applications To:

John H. Spang
Chairman, Search Committee
Department of Geology
Texas A&M University
College Station, Texas 77843.

Texas A&M is an equal-opportunity affirmative-action employer.

Faculty Position/Bryn Mawr College. One year, junior level appointment for '83–84. Teaching responsibilities: four one-semester courses, including undergraduate structural geology and graduate seminar. Additional expertise in stratigraphy, sedimentology or oceanography preferred; strong background in computer applications in geology desired. Candidates must have completed all Ph.D. requirements. Send letter of application/resume and transcripts to:

M. L. Crawford, Department of Geology
Bryn Mawr College
Bryn Mawr, PA 19010

Bryn Mawr College is an equal opportunity employer.

Research Faculty Positions in Oceanography/University of Southern California. Applications are invited for three research faculty positions. Individuals with established records of excellence in sea-going research programs in biological, geological, chemical and physical oceanography are sought. At least one appointment each in geological and biological oceanography is planned. Individuals applying should have coastal oceanography as their major geographical area of interest. Special attention would be given to applications from interdisciplinary teams, e.g., in benthic boundary layer studies, interaction of plankton and circulation, chemical/biological transformations, etc. These positions carry a commitment of up to 50% of salary from USC sources. Appointments are expected to be made by July 1, 1983. Contact:

Dr. Richard Dugdale, Director
Allan Hancock Foundation
University of Southern California
Los Angeles, CA 90089-0372

or

Dr. Robert Douglas, Chairman
Department of Geological Sciences
University of Southern California
Los Angeles, CA 90089-0741

USC is an equal opportunity/affirmative action employer.

Isotope Geologist/University of Wyoming. The Department of Geology/Geophysics invites applications for a tenure track position at the assistant professor level in isotope geology. The applicant's field of specialty may be stable or radiogenic isotopes. The successful candidate will be expected to teach undergraduate and graduate courses and conduct his/her own research program.

Current research at the University of Wyoming includes: crustal evolution in the Archean and Proterozoic; the systematics of magma contamination; carbonate diagenesis; fluid-rock interaction; and the tectonic evolution of compressional and extensional orogenic belts. We hope the successful candidate will complement these studies as well as develop a strong, independent program. Applicants should submit a vita, transcripts, a letter describing future research interests, and names of three references to Dr. Robert S. Houston, Head, Dept. of Geology/Geophysics, PO Box 3006, University Station, University of Wyoming, Laramie, WY 82071. Closing date for applications is February 28, 1983.

The University of Wyoming is an equal opportunity/affirmative action employer.

Research Positions/Lunar and Planetary Laboratory. The Lunar and Planetary Laboratory at the University of Arizona has research positions open for Planetary Scientists, with Planetary Astronomy and Planetary Geology being areas of greatest interest to the Laboratory at this time. Researchers at the Laboratory have access to the University's observatories, a wide range of organized instrumentation, a complete collection of planetary images, computers and laboratory facilities. The research ranks in the Laboratory, namely Assistant Planetary Scientist, Associate Planetary Scientist, and Planetary Scientist parallel the tenure track ranks of Assistant, Associate and Full Professor. The Laboratory is interested in making appointments at the Assistant or Associate Planetary Scientist level. These are not tenurable and not state-funded positions. Salary levels are commensurate with equivalent tenure-track ranks. Researchers in these positions will be expected to supply a significant portion of all of their salaries through their grants and contracts.

Applicants should submit a curriculum vita, list of publications, and the names of three references by April 30, 1983, to L. L. Wilkening, Director, Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona, 85721.

The University of Arizona is an equal opportunity, affirmative action employer.

Faculty Teaching and Research Position/Institute of Marine Science, University of Alaska, Fairbanks. Research interests should include the numerical modeling of estuarine, coastal and open ocean physical oceanography in subpolar or polar environments. Participation in interdisciplinary studies is encouraged. Applicant should have an extensive background in hydrodynamics and numerical modeling. Ph.D. degree in physical oceanography is preferred (or its equivalent in training or experience). Rank and salary will be determined by experience. Candidates should send resume and names of three referees to: Dr. Vera Alexander, Director, Institute of Marine Science, University of Alaska, 99701. Closing Date March 15, 1983.

The University of Alaska is an EOAA Employer and Educational Institution.

Your application for employment with the U of A may be subject to public disclosure if you are selected as a finalist.

University of Alberta/Theoretical Geophysicist. Applications are invited for the positions of a Postdoctoral Fellow or Research Associate in the field of theoretical studies of direct and inverse problems in seismic wave propagation for complicated geological structures. The positions are available immediately and are initially for a one year period with the possible extension for a second year.

The annual salary for the Postdoctoral Fellow position is in the $17,000–$19,500 range. The minimum annual salary for the Research Associate is $24,000.

Interested applicants should submit a resume, a summary of research interests and arrange for three letters of reference to reach

Dr. F. Hron or Dr. M. Razavy
Department of Physics
University of Alberta
Edmonton, Alta., T6G 2J1
Canada

from whom further particulars can be obtained.

Chairman, Department of Geology/Louisiana State University. The Department of Geology, LSU, invites applications for the position of Professor and Chairman, to be filled during the 1983–84 academic year. We are seeking an earth scientist of national or international stature with research, academic, or industrial experience. The Department is a well-equipped, research-oriented organization with a faculty that should approach twenty by 1985. Construction of a new Geology Building annex is scheduled to begin within one year. LSU's location and strong ties to industry make this position particularly attractive relative to the Department's growth potential.

The successful candidate must demonstrate outstanding leadership ability. Applicants should submit to the Search Committee their curriculum vitae and a statement of their philosophy of governance. They should also arrange to have three letters of recommendation sent directly to the Search Committee. Preference will be given to applications received by February 15, 1983. Applications, nominations, and inquiries should be addressed to:

Clyde H. Moore
Chairman, Search Committee
Department of Geology
Louisiana State University
Baton Rouge, LA 70803

LSU is an equal opportunity/affirmative action employer.

Department Head/Physics and Atmospheric Science, Drexel University. Drexel University seeks an outstanding individual to be Head of the Department of Physics and Atmospheric Science beginning Fall, 1983. Applicants should have extensive research/teaching experience and should have demonstrated appropriate leadership ability. The appointment is non-rotating and the successful applicant will be concurrently a Full Professor with tenure.

Drexel is a private, technological University with an enrollment of 10,000, most of whom participate in a unique cooperative program. It is located in the West Philadelphia Community of University City, in close proximity to two other educational institutions and a major science center. The Department of Physics and Atmospheric Science has 30 faculty, plus an average of five visitors per year, and 40 graduate and 80 undergraduate students. There is significant research activity in three major areas: Experimental Physics (biophysics, nuclear physics, quantum optics, solar energy, solid state physics), Theoretical Physics (atomic and molecular physics, biomathematics, mathematical physics, nonlinear dynamics, nuclear physics, quantum optics, solid state physics) and Atmospheric Science (mesometeorology, remote sensing of the atmosphere and satellite meteorology). Funding for these research activities exceeds one million dollars per year.

Screening of applicants will begin on *March 15, 1983*. Nominations or inquiries should be directed to:

Dr. T. K. Lim, Chairperson
Departmental Head Search Committee
Department of Physics and Atmospheric Science
Drexel University
Philadelphia, PA 19104
(215) 895-2717

DREXEL UNIVERSITY IS AN EQUAL OPPORTUNITY AND AFFIRMATIVE ACTION EMPLOYER.

EOS

Transactions, American Geophysical Union

Send double-spaced manuscripts (four copies) to *Eos*, AGU, 2000 Florida Avenue, N.W., Washington, D.C. 20009, or send them directly to one of the associate editors with a copy to the above address.

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Eos, Transactions, American Geophysical Union (ISSN 0096-3941) is published weekly by the American Geophysical Union from 2000 Florida Avenue, N.W., Washington, D.C. 20009. Subscription price to members is included in annual dues ($20.00 per year). Information on institutional subscriptions is available on request. This issue $5.00. Second-class postage paid at Washington, D.C., and at additional mailing offices.

Views expressed in this publication are those of the authors only and do not reflect official positions of the American Geophysical Union unless expressly stated.

Cover. Slushflows are a common, but rarely observed, phenomenon in arctic and subarctic regions. The photograph shows the upper portion of a slushflow track in Atigun Pass, Central Brooks Range, Alaska. Approximately 30 such events have been observed in this area during the last four spring breakup periods. The slush, which is fully saturated and consequently very dense, releases instantaneously in a manner similar to slab snow avalanches. The combination of steep slopes, high-density material, and confinement within narrow alpine chutes produces flow rates estimated at several tens of meters per second. Evidence of superelevation of the flow (approximately 10 m vertical) on the outside curve of the bend (left center in photo) implies it is in a supercritical state. (Photo courtesy of Lawrence J. Onesti, associate professor, Department of Geography, Indiana University.)

Faculty Positions/University of Hawaii. *Chemical Oceanographer/Marine Geochemist.* The Department of Oceanography and the Hawaii Institute of Geophysics at the University of Hawaii have a joint supported, state funded, tenure track faculty position available at any level through full professor. Qualified applicants are being sought for this position with a 1983 starting date. Candidates with a strong teaching and research background with specialties in the area of stable isotope geochemistry and marine geochemistry are encouraged to apply, but all applicants in the area of chemical oceanography will be considered. The applicant will be expected to supervise and support graduate students, teach graduate courses, and obtain funding for research. The Department of Oceanography and the Hawaii Institute of Geophysics have excellent research facilities housed in the new six-story Marine Science Building and the Hawaii Institute of Geophysics Building. Two nuclide isotope ratio mass spectrometers with computerized data reduction, micro inlet systems, triple collectors and carbonate, silicate, and sea-water extraction systems are available in addition to complete geochemical analytical facilities with electron microprobe, SEM-TEM, atomic absorption, X-ray fluorescence and diffraction, and organic geochemical instrumentation. Applicants should possess a Ph.D. in oceanography or related earth science, and at least one year of research and teaching experience. A curriculum vita, names of three references and a statement describing research objectives should be sent to Dr. Fred Mackenzie, Chairman, Search Committee, Department of Oceanography, University of Hawaii, Manoa, 1000 Pope Road, Honolulu, Hawaii 96822. Closing date, March 1, 1983.

Geological Oceanographer/Sedimentary Geochemist. The Department of Oceanography and the Hawaii Institute of Geophysics have a state-funded, tenure track faculty position available at any level through full professor in the fields of geological oceanography/marine geology-geochemistry, with 1983 starting date. Candidates with interests in tectonics, sedimentology, or geochemistry in marine sediments with some experience in the Pacific Ocean region are especially encouraged to apply. The Department of Oceanography and the Hawaii Institute of Geophysics have recently acquired a Sea-MARC II mapping, Geochemical-geological facilities include fully equipped, low-temperature geochemical experimental laboratories and sedimentological equipment, SEM-TEM, atomic absorption, X-ray fluorescence and diffraction, organic geochemical instrumentation and two large computers. The candidate will be expected to supervise and support graduate students, teach graduate courses, and obtain funding for research. Applicants should possess a Ph.D. in geology, oceanography or related earth sciences, and should have at least one year of research and teaching experience. A curriculum vita, names of three references, and a statement describing research objectives should be sent to Dr. Stanley B. Margolis, Department of Oceanography, University of Hawaii, Manoa, 1000 Pope Road, Honolulu, Hawaii 96822. Closing date, March 1 1983.

We encourage applications from women and members of minority groups. The University of Hawaii is an equal opportunity/affirmative action employer.

Faculty Position/Northwestern University. The Department of Geological Sciences is seeking a creative individual whose interests are compatible with the existing research strengths of the Department. These are in the areas of geophysics, tectonics, geochemistry, sedimentary geology, paleoclimatology. While area of specialization is open, candidates should have a strong commitment to graduate instruction and research. An appointment to a tenure track Assistant Professorship is anticipated. Applicants should submit a resume and the names of three references to:

B. J. Wood
Department of Geological Sciences
Northwestern University
Evanston, IL 60201
312-492-3442.

The closing date is February 18, 1983.

An equal opportunity employer.

Faculty Positions/University of Washington, Department of Geological Sciences. *Position 1.* The department seeks a *geologist* with demonstrated success in teaching introductory geology, whose primary responsibility would be to teach and coordinate Geological Sciences 101, a large lecture/lab course for non-majors. Rank of Lecturer or Assistant Professor depending on research experience and availability of funding. Beginning September 1983.

Position 2. Possible opening for geologist with strong quantitative, theoretical background as well as commitment to field related studies. We are particularly interested in the area of economic geochemistry. Successful candidate would be expected to carry out a rigorous research program as well as to contribute to teaching responsibilities at both the undergraduate and graduate level. Assistant Professor (tenure-track) rank, beginning September 1983.

Position 3. Electron microprobe specialist. This position is supported at the 50% level by the department, and would require the successful applicant to provide up to 50% salary support from research grants or other sources. This is a non-tenured faculty position at the rank of Research Assistant Professor. Candidates should have a record of successful grant-supported research in mineralogy/petrology involving use of the electron microprobe. The position requires supervision and operation of the microprobe facilities, and teaching one course. This position will be available after January 1983.

Applicants should send vita, letter of teaching and research interests, and names of four references to John B. Adams, Chairman, Department of Geological Sciences, AJ-20, University of Washington, Seattle, Washington 98195 by *1 March 1983*.

The University of Washington is an affirmative action/equal opportunity employer.

Hydrogeologist. The Department of Geology at Northern Illinois University has an opening for a senior, research-oriented scientist to head a new water/environmental research group. The position is tenure-track at the rank of Associate or Full Professor.

The successful candidate will chair a search committee responsible for recruitment of additional, anticipated faculty in environmental and water-related sciences. This group, together with current faculty, will have primary responsibility for a Ph.D. program emphasizing geochemistry/hydrogeology/environmental sciences.

Available facilities include a departmental computer (Harris 500), gas and solid-source mass spectrometer, atomic absorption, and a wide variety of geophysical equipment for both surface exploration and down-hole logging.

Please send resume and the names and addresses of three referees to L. D. McGinnis, Dept. of Geology, Northern Illinois University, DeKalb, Illinois, 60115.

Northern Illinois University is an affirmative-action/equal-opportunity employer.

University of Washington/Meteorologist. Possible opening for meteorologist with strong background in atmospheric turbulence, transfer processes, atmospheric physics, and experience in field experiments. The successful candidate would be expected to carry out an extensive research program, supervise graduate students, and teach courses at both the undergraduate and graduate levels. Assistant Professor (tenure-track) rank, beginning September 1983. Possibility exists to hire at the Associate Professor level. A higher rank is possible for an exceptionally well qualified individual.

Applicants should send vita, letter of teaching and research interests, and names of four references to Joost A. Businger, Chairman, Department of Atmospheric Sciences, AK-40, University of Washington, Seattle, Washington 98195 by *1 March 1983*.

The University of Washington is an affirmative-action/equal opportunity employer.

Faculty Positions/The University of Iowa. The Department of Physics and Astronomy anticipates one or two openings for tenure-track assistant professors or visiting professors of any rank in August 1983. Preference will be given to experimentalists in any area for the tenure-track positions. Current research interests include astronomy, atomic, condensed matter, elementary particle, laser, nuclear, plasma, and space physics. The positions involve undergraduate and graduate teaching, guidance of research students, and personal research. Interested persons should send a résumé and a statement of research interests, and have three letters of recommendation sent to *Search Committee, Department of Physics and Astronomy, The University of Iowa, Iowa City, IA 52242.*

The University of Iowa is an equal opportunity/affirmative action employer.

First Announcement
International Symposium on Deep Structure of The Continental Crust: Results from Reflection Seismology

The conference will be held during June 26, 27, 28, *1984*, on the Cornell University campus in Ithaca, New York. The technical sessions will cover, amongst others, the following topics:

- *Results of seismic reflection profiling of the deep continental crust in countries throughout the world.*
- *Structure of orogenic belts.*
- *Structure of continental rifts.*
- *Nature of the Moho.*
- *Mechanisms of continental accretion.*
- *State-of-the-art techniques in deep seismic reflection profiling.*

A comprehensive proceedings of the conference will be published.

Steering Committee of the conference:
—*Muawia Barazangi, Coordinator, Department of Geological Sciences, Cornell University, Ithaca, New York 14853, Telephone: (607) 256-6411, Telex No. 937478*
—*Albert Bally (Rice University)*
—*Robert Hamilton (U.S. Geological Survey)*
—*Leonard Johnson (U.S. National Science Foundation)*
—*Robert Phinney (Princeton University)*
—*Donald Turcotte (Cornell University)*

For additional information concerning submission of abstracts and/or to attend the conference please contact the Coordinator. Participation may be limited.

Faculty Position/Princeton University Department of Geological and Geophysical Sciences. We are looking for an exceptionally creative individual in the general area of paleontology—stratigraphy—sedimentology for tenure-track appointment as Assistant Professor. Rapid increases in understanding of the processes and history of the earth's surficial environment have come about through analytical and theoretical advances in many specialities, such as magnetic stratigraphy, clay mineralogy and geochemistry, seismic stratigraphy, isotopic and microanalytical studies of fossils and sediments, sedimentation related to crustal tectonics, and mathematical analysis of stratigraphic and paleontological data. We seek candidates with strong interdisciplinary research interests in areas such as those listed, with the analytical skills and foresight to work effectively on the frontier. Within the department, the appointee should be able to take responsibility for an area such as stratigraphy, paleontology, or sedimentology, and provide a broad historical perspective. We plan to back up this appointment by our program for a general expansion of laboratory facilities, as appropriate.

Inquiries should be made to: R. A. Phinney, chairman, at the above address, or by phone, (609) 452-4100. While later applications will be considered, we would like to have them by the 31st of January, 1983, or earlier, if possible. Applicants should submit: resume, names of at least three references, and a statement of research plans and priorities.

Princeton University is an equal opportunity affirmative action employer.

Postdoctoral Research Associate Positions/Johns Hopkins University, Applied Physics Laboratory. Positions are available for studies of planetary magnetospheres, and for studies of earth magnetospheric and auroral physics. Selected candidates will participate in the analysis and interpretation of data obtained from deep space probes (Voyager), or particle, field, and atmospheric emissions data from earth orbiting spacecraft. Positions are one year renewable opportunities with flexible starting dates. Applications should be addressed to Mr. Stevan F. Sayre, Department LER-258, The Johns Hopkins University, Applied Physics Laboratory, Johns Hopkins Road, Laurel, MD 20707.

An Equal Opportunity Employer M/F.

Physical Oceanographer/Oregon State University. Assistant or Associate Professor, depending on experience. Applicants may be observationalists or theoreticians but must have a Ph.D. in the physical sciences, have demonstrated the ability to conduct independent high-quality research and are expected to obtain research funding. Duties include teaching and supervision of graduate students. Interested candidates should submit a resume and names of three references by 1 March 1983 to: G. Ross Heath, Dean, School of Oceanography, Oregon State University, Corvallis, OR 97331.

Affirmative Action/Equal Opportunity Employer.

Physical Oceanography/Memorial University of Newfoundland. Applications are invited for a faculty appointment in physical oceanography which is to be made in the PHYSICS DEPARTMENT for June 1, 1983, subject to final budgetary approval. Rank and salary are negotiable and commensurate with the qualifications of the appointee. Considerable research experience beyond a Ph.D. degree is preferred. The position offers a challenging academic career with stimulating research opportunities focussing in the Northwest Atlantic and the Canadian Arctic. The Department has an active group engaged in field studies of fjords in Newfoundland, Labrador and Baffin Island and the submarine canyons of the Grand Banks, and in the application of a numerical sea-ice model to the Labrador Sea and Baffin Bay. This group interacts closely with other oceanographers, both inside and outside the University, through the Newfoundland Institute for Cold Ocean Science.

Candidates are sought whose primary interests are in theoretical investigations of continental shelf and coastal dynamics but ours is a new and growing program and qualified individuals with experience in any area of physical oceanography should apply. An interest in interdisciplinary research and co-operation would be an asset. The appointment will include teaching duties at the graduate and undergraduate levels. Applications, including curriculum vitae and the names of three referees, or requests for information should be addressed to:

Head, Department of Physics,
Memorial University of Newfoundland,
St. John's, Newfoundland, Canada,
A1B 3X7.
Telephone: (709) 737-8738

In accordance with Canadian Immigration regulations this advertisement is directed to Canadian citizens and landed immigrants in the first instance.

Earth Sciences/University of Leeds. Applications are invited for *two* positions available from 1 October 1983.

The appointee to the *Lectureship in Chemical Oceanography or Sedimentary Geochemistry* would preferably have interests in interactions between sediments and natural waters. Facilities exist for elemental and isotopic analyses of sea water and particulate matter. The Department is also active in related areas of sedimentology, isotope geology, sedimentary ore deposits, theoretical petrology and a range of analytical geochemistry.

The appointee to the *Lectureship in Geophysics* could have qualifications and interests in any branch of exploration geophysics or solid earth geophysics. Present activities in these areas include exploration seismology, global seismology and seismicity, palaeomagnetism, tectonophysics, gravity and magnetics and electrical methods.

The Department of Earth Sciences is an integrated geology-geochemistry-solidearth geophysics department teaching MSc in Geochemistry and Geophysics as well as undergraduates, and with a research school of 30+ students.

Salary on the scale of £6375–£13,505 according to age, qualifications and experience.

Application forms (not essential) and further particulars may be obtained from the Registrar, University of Leeds, Leeds LS2 9JT, West Yorkshire, UK.

Closing date *1 March 1983* (by telegram in the first instance if necessary for candidates outside the UK).

Faculty Position in Oceanography/University of Miami. Applications are invited for a tenured-earning faculty appointment in physical oceanography; level of appointment and salary commensurate with qualifications. Applicants should have a record of scholarly publications demonstrating the ability to interpret oceanographic observations, and several years experience in planning and execution of oceanographic field experiments. Duties include teaching graduate level courses in physical oceanography and supervising research of graduate students. Send curriculum vitae, publication list and names of three references to: Dr. Friedrich Schott, Chairman, Division of Meteorology and Physical Oceanography, Rosenstiel School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, Florida 33149.

The University of Miami is an affirmative action/equal opportunity employer.

Iowa State University of Science and Technology, Department of Earth Sciences/Faculty Positions. Applications are invited for a tenure-track faculty position in mineral resources. Rank is at the assistant or associate professor level, dependent upon qualifications. The successful applicant will be expected to develop a strong research and graduate student program in mineral resources/economic geology and will teach undergraduate and graduate courses in this subject. An applied field orientation is preferred.

Iowa State has established a Mining and Mineral Resources Research Institute in order to support and develop research and education in mineral resources. An interdepartmental graduate minor in Mineral Resoures has also been established. In addition to the appointment in the Department of Earth Sciences, there will be full opportunities to interact with these programs.

Completion of the Ph.D. prior to appointment is strongly preferred. In addition, research ability shown by other publications and/or postdoctoral or industrial experience will be an advantage. The position is currently available and is expected to begin no later than September 1983. For application information, please write to:

Bert E. Nordlie, Chairman
Department of Earth Sciences
253 Science I
Iowa State University
Ames, Iowa 50011

Iowa State University is an equal opportunity affirmative action employer.

STUDENT OPPORTUNITIES

Graduate Research Assistantships Available/Department of Meteorology, South Dakota School of Mines and Technology. Several graduate research assistantships are available beginning Fall 1983 in the areas of numerical cloud modeling, cloud physics, weather modification, radiative transfer, radar meteorology, mesometeorology, and air pollution chemistry and physics. Graduate study can lead to a Master of Science degree in Meteorology at SDSM&T as well as a Ph.D. through a cooperative program with Colorado State University. Current areas of research emphasis include: 1) numerical cloud modeling at the single-cloud and mesoscale level, including acid rain formation, 2) design and evaluation of field experiments and operations in weather modification, including hail suppression, 3) aircraft and radar investigations of thunderstorms, 4) radiation and remote sensing from satellites, 5) mesoscale data analysis, and 6) analysis and source apportionment of atmospheric particulate matter. Stipends for the nine-month academic year vary from $4,400 to $5,600. Full time summer employment generally is available. For further information contact Dr. Briant L. Davis, Acting Head, Department of Meteorology, South Dakota School of Mines and Technology, Rapid City, South Dakota 57701-3995 (telephone 605/394-2291).

Graduate Research and Teaching Assistantships in Marine Geochemistry. The Hawaii Institute of Geophysics invites applications from students interested in M.S. and Ph.D. programs in marine chemistry and geochemistry. Areas of research include marine organic and inorganic geochemistry, isotope geochemistry, sediment-seawater-organism interactions, sediment diagenesis, geochemical cycling, and tropical seawater chemistry. Current stipends are $447–576 per month for 10 or 12 month appointments. For further information, write:

Dr. K. E. Chave, Head
Marine Geochemistry Division
Hawaii Institute of Geophysics
1000 Pope Rd.
Honolulu, HI 96822.

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Roy Young, Caribe Star Route, Nederland, CO 80466, 303-258-3846.

Meetings

Announcements

IAHS at IUGG

The International Association of Hydrological Sciences (IAHS) will participate in the XVIII General Assembly of the International Union of Geodesy and Geophysics (IUGG) in Hamburg, F.R.G., August 15–27, 1983. Here is a list of the relevant symposia, their dates, and convenors.

For additional details on arrangements or on the union symposia, contact the chairman of the local organizing committee, W. Zahel, IUGG Hamburg Messe und Congress GmbH, Congress Organization, Postfach 30 23 60, 2000 Hamburg 36, F.R.G. Additional information on IAHS symposia or workshops may be obtained from the convenor or the IAHS General Secretary, John C. Rodda, Institute of Hydrology, Wallingford, Oxon OX10 8BB, UK.

'Sea Ice Margins,' slated for August 18–19, is the union symposium organized by IAHS. It is sponsored by IAHS (ICSI), the International Association for Physical Sciences of the Ocean (IAPSO), and the International Association of Meteorology and Atmospheric Physics (IAMAP). The convenor is Robin D. Muench, senior research oceanographer, Science Applications, Inc., Suite 36, 13400 B Northrup Way, Bellevue, WA 98005.

There are five union symposia in which IAHS is participating. 'Geophysics of the Polar Regions' is sponsored by IUGG-Bureau and all associations. Mark Meier is the coconvenor. Detailed information may be obtained from P. Melchior, Observatoire Royal de Belgique, Avenue Circulaire 3, B-1180 Brussels, Belgium.

'Management of Earth Science Data,' scheduled for August 16–17, is being sponsored by the International Association of Geomagnetism and Aeronomy (IAGA), ICL, and all other associations. The IAHS coconvenor is F. Bultot, Institute Royal Meteorologique, Avenue Circulaire 3, B-1180 Brussels, Belgium.

'Assessment of Natural Hazards,' sponsored by IASPEI, IAVCEI, IAHS, and IAPSO (Tsunami C), will be held August 16–19. The IAHS coconvenor is J. V. Sutcliffe, Institute of Hydrology, Maclean Building, Crowmarsh Gifford, Wallingford, GB-Oxon OX10 8BB, UK.

'Heat Flow and Geothermal Processes,' sponsored by the International Association of Seismology and Physics of the Earth's Interior (IASPEI), the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), and IAHS, will be held August 23–24. The IAHS coconvenor is L. Alfoldi, National Water Authority, Fo 44–50, H-1011 Budapest, Hungary.

The symposium 'Coastal and Near-Shore Zone Processes' is divided into two sections: physical processes and chemical processes. The symposium on physical processes, to be held August 16–17, will be coconvened by Robert Beardsley, Woods Hole Oceanographic Institution, Woods Hole, Mass. 02543. The chemical processes section of the symposium, to be held August 18, will be coconvened by J. C. Duinker, The Netherlands Institute of Sea Research, P.O. Box 59, 1790 AB Den Burg, Texel, Netherlands. The symposia are sponsored by IAPSO and IAHS.

Another symposium of interest to IAHS is 'Polar Meteorology and Climatology,' to be held August 16–18. The IAHS representative is E. F. Roots, Department of the Environment, Ottawa K1A 0H3, Canada. Sponsors include IAMAP (ICPM) and SCAR.

There are five IAHS symposia. 'Hydrological Applications of Remote Sensing and Remote Data Transmission,' cosponsored by WMO and UNESCO, will be held August 18–25. The convenor is A. I. Johnson, Woodward-Clyde Consultants, 2909 West 7th Avenue, Denver, Colo.

'Relation of Groundwater Quality,' cosponsored by UNESCO, is slated for August 25–26. The convenor is F. Dunin, CSIRO Division of Plant Industry, P.O. Box 1600, Canberra City, ACT 2601, Australia.

'Hydrology of Humid Tropical Regions with Particular Reference to the Hydrological Effects of Agriculture and Forestry Practice,' also cosponsored by UNESCO, will be held August 17–19. The convenor is R. Keller, Geographisches Institut I, Albrecht-Ludwigs-Universität, 7800 Freiburg, F.R.G.

The symposium 'Scientific Procedures Applied to the Planning, Design, and Management of Water Resources Systems' will be held August 22–24. The convenor is E. Plate, Institut Wasserbau III, Universität Karlsruhe, 7500 Karlsruhe, F.R.G. UNESCO is cosponsoring the symposium.

'Dissolved Loads of Rivers and Surface Quantity/Quality Relationships,' to be held August 16–18, also is being cosponsored by UNESCO. The convenor is B. Webb, Department of Geography, University of Exeter, Amory Building, Rennes Drive, Exeter EX4 4RJ, U.K.

Six IAHS workshops round out the IAHS participation in the IUGG general assembly. 'New Approaches in Water Balance Computations,' to be held August 22–23, will be cosponsored by UNESCO. The convenor is A. van der Beken, Vrije Universiteit, Pleinlaan 2, 1050 Brussels, Belgium.

'Hydrological Aspects of Tropical Cyclones,' to be cosponsored by WMO and UNESCO, will be held August 16. The convenor is R. Keller, whose address is listed in the previous paragraph.

'Glacier Mass Balance and Runoff' will be held August 25. The convenor is V. Kotlyakov, Institut Geografi, Akademiya Nauk SSSR, Moscow, USSR.

'Large-Scale Snow Studies' will be held August 26. The convenor is A. Rango, Hydrological Sciences Branch, Code 929, Goddard Space Flight Center, Greenbelt, Md. 20771.

The symposium titled 'The Role of Hydrology in Water Resources Systems: Experiences and Perspectives for the Future' will be held August 25–26. It will be cosponsored by UNESCO. The convenor is E. Plate, whose address is listed above.

'Strategies for Hydrological Sciences in Developing Countries' will be held August 22–23. The convenor is N. B. Ayibotele, Water Resources Research Institute (CSIR), P.O. Box M32, Accra, Ghana.

Water Resources

The Fifth International Conference on Finite Elements in Water Resources, to be held at the University of Vermont in Burlington, June 18–22, 1984, will focus on mathematic modeling of water resources, using modern numerical techniques. Because finite-element methods have been shown to be a powerful means for analyzing water resource problems, the principal objectives of the conference are to provide an exchange of experiences in practical applications and to establish a forum for discussions about accuracy, economy, and the improvement and limitations of the method. Other related methods also will be within the scope of the conference.

Among the topics to be covered are groundwater and seepage; tidal processes; ocean dynamics; river flow problems; wave modeling; fluid forces on structures; viscous flow; turbulence modeling; transport phenomena; heat waste problems; seawater intrusion; water quality; environmental protection; meteorological dynamics; sedimentation processes; parameter identification; calibration techniques; flow control; finite-element techniques; boundary-element techniques; numerical mathematics; software systems; pre- and post-data processing; and hardware and software developments.

Abstracts, not to exceed 300 words, should be submitted by September 30, 1983. Completed papers of those accepted for presentation will be due February 1, 1984. For additional information about the conference or about the submission of abstracts, contact J. P. Laible, Finite Element Conference, Department of Civil Engineering and Mechanical Engineering, University of Vermont, Burlington, VT 05405. Other members of the organizing committee are C. A. Brebbia (University of Southampton, U.K.), W. G. Gray (Princeton University), and G. F. Pinder (Princeton University). Local organization is being handled by the College of Engineering and Mathematics and the Water Resources Research Center at the University of Vermont.

Middle Atmosphere Science

A call for papers has been issued for the joint IAMAP/IAGA Symposium on Middle Atmosphere Sciences (MAS), to be held during the XVIII Assembly of IUGG in Hamburg, F.R.G. Eleven half-day sessions, beginning on August 20, 1983, are planned for MAS.

The emphasis of the symposium program will be on the dynamics, energetics, and chemistry of the middle atmosphere, defined as the region from 10 to 120 km above the earth. Special problems included are electrodynamics of the middle atmosphere and the physics and chemistry of ions, aerosols, and noctilucent clouds. In addition, mutual interactions of the middle atmosphere regions and coupling with the troposphere and upper mesosphere will be discussed. Contributed papers on significant observational, theoretical, and experimental results are solicited.

Topics to be included in the symposium are modeling of the middle atmosphere, including the radiation budget; coupling between the stratosphere, mesosphere, and thermosphere; climatology of the middle atmosphere; gravity waves, turbulence, and parameterization of related transport in middle atmosphere models; dynamics, including troposphere coupling; remote sensing; ultraviolet flux, photochemical processes, and related chemistry; electrodynamics of the middle atmosphere; trace species in the middle atmosphere; noctilucent clouds; and the physics and chemistry of ions and aerosols in the middle atmosphere.

MAS is being jointly organized by the International Association of Meteorology and Atmospheric Physics (IAMAP) and the International Association of Geomagnetism and Aeronomy (IAGA). It is cosponsored by SCOSTEP and COSPAR.

The deadline for submission of abstracts is March 1, 1983. The abstract original should be sent to the secretary general of IAMAP, S. Ruttenberg, NCAR, P.O. Box 3000, Boulder, CO 80307. In addition, a copy of the abstract should be sent to each of the convenors: A. Ebel (IAMAP), Institute for Geophysics and Meteorology, University of Cologne, D-5000 Cologne 41, Federal Republic of Germany, and P. C. Simon (IAGA), Institute d'Aéronomie Spatiale, 3 Ave. Circulaire, B-1180 Bruxelles, Belgium. Detailed instructions about the abstract format are included in the second bulletin of the IAMAP General Assembly, which is available from S. Ruttenberg, and in the third bulletin of the XVIII IUGG General Assembly, which is available from the chairman of the local organizing committee, W. Zahel, Insitut für Meereskunde der Universität Hamburg, Heimhuderstrasse 71, 2000 Hamburg 13, F.R.G.

AGU Congressional Science Fellowship

The individual selected will spend a year on the staff of a congressional committee or a House or Senate member, advising on a wide range of scientific issues as they pertain to public policy questions.

Prospective applicants should have a broad background in science and be articulate, literate, flexible, and able to work well with people from diverse professional backgrounds. Prior experience in public policy is not necessary, although such experience and/or a demonstrable interest in applying science to the solution of public problems is desirable.

The fellowship carries with it a stipend of up to $27,000, plus travel allowance.

Interested candidates should submit a letter of intent, a curriculum vitae, and three letters of recommendation to AGU. For further details, write or call Member Programs Division, Congressional Fellowship Program, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20009 (telephone 462-6903 or 800-424-2488 outside the Washington, D.C. area).

Deadline: March 31, 1983

Geophysical Year

The complete Geophysical Year last appeared in the December 21, 1982, *Eos*.

A boldface meeting title indicates sponsorship or cosponsorship by AGU.

Changes

Aug. 19–23, 1985 Sixth Gondwana Symposium, to be cosponsored by AGU.

Call for Papers

Abstracts must be received at the AGU office by 5:00 P.M. on March 9 to be on time. Late abstracts (1) may be summarily rejected by program chairman, (2) may not be published in advance of the meeting, and (3) if accepted, will be charged a $25 late fee in addition to the regular publication charge.

The 1983 Spring Meeting of the American Geophysical Union will be held in Baltimore from May 30–June 3 at the Baltimore Convention Center. Blocks of rooms are being held at the Hilton, the Hyatt Regency, the Holiday Inn, the Howard House, and the Harbor City Inn for those attending. Housing and registration forms will be sent to corresponding authors.

General Regulations

Abstracts may be rejected without consideration of their content if they are not received by the deadline or are not in the proper format. Abstracts may also be rejected if they contain material outside the scope of AGU activities or if they contain material already published or presented elsewhere. Only one contributed paper by the same first author will be considered for presentation; additional papers (unless invited) will be automatically rejected.

Only AGU members may submit an abstract. The abstract of a nonmember must be accompanied by a membership application form (with payment), or it must be sponsored by an AGU member.

There is a publication charge of $40 ($30 if prepaid) for each abstract. The publication charge is $20 if the first author is a student. Both invited and contributed papers are subject to the publication charge. Prepayment of the publication charge can save money. Send a check for $30 ($15 for students) with your abstract. The abstract must be received at AGU by March 9 to avoid an additional $25 charge.

AGU will acknowledge receipt of all abstracts. Notification of acceptance and scheduling information will be mailed to corresponding authors in late April.

Abstracts

The abstract page is divided into two parts: the abstract itself and the submittal information. Follow the instructions for both carefully. Please use a carbon ribbon to type the material, and do not exceed the maximum dimensions (11.8 cm by 18 cm) of the abstract. Abstracts that exceed the noted size limitations will be trimmed to conform.

The meeting program will be prepared by photographing the abstracts exactly as they are received. Use the model abstract to prepare the final version. Submission of an abstract for an AGU meeting is presumed to carry with it permission for AGU to reproduce the abstract in all editions of *Eos* and in the programs and reports relating to the meeting. It is also presumed to permit the free copying of those papers. Although *Eos* is a copyrighted journal, authors are not requested to transfer copyright. Copyright, where it exists, will be reserved by the authors.

Submittal Information

Numbers refer to the items in the submittal block on the sample abstract.

1. Title of meeting.

2. Identification (only members may submit an abstract; this includes invited authors): Type identification number of one member author (ID number is the line consisting of four letters followed by the six digits; see members' mailing label on *Eos* or journals), or if no author is an AGU member, type the ID number of the member sponsor (sponsor's name must also appear on the abstract at the end of the author portion). If no ID number is given, a membership application and dues payment must accompany the abstract. Call AGU (800-424-2488 or 462-6903 if you are in the Washington, D.C., area) immediately if you need an application.

3. Corresponding address: Give complete address and phone number of author to whom all correspondence (acknowledgment and acceptance letters) should be sent. Abbreviate as much as possible.

4. Section of AGU to which abstract is submitted (use the following letter abbreviations): A (Atmospheric Sciences); G (Geodesy); GP (Geomagnetism and Paleomagnetism); H (Hydrology); O (Oceanography); P (Planetology); S (Seismology); SA (Aeronomy); SM (Magnetospheric Physics); SC (Cosmic Rays); SS (Solar and Interplanetary Physics); T (Tectonophysics); V (Volcanology, Geochemistry, and Petrology); U (Union).

5. Type title of special session (if any) to which submittal is made.

6. Indicate your preference for a particular kind of presentation by one of the following letters: O, oral; P, poster. The chairman may assign you to either of these types of presentation in order to fit his program plan.

7. Percent of material previously presented or published, and where.

8. Billing information.

(*a*) Complete billing address if other than the corresponding address (item 3 above).

(*b*) If purchase order is to be issued, indicate number upon submittal of abstract.

Invoices returned to AGU because of insufficient billing information will be assessed an additional charge of $10.00.

(*c*) If a student member is the first author, the student publication rate is applicable. Indicate student rate applicable.

(*d*) If prepaid, enter amount enclosed.

9. Indicate whether paper is C (contributed) or I (invited). If invited, list name of inviter.

Poster Sessions

A large, centrally located meeting room will be set up for poster presentations. Experience from recent AGU meetings and from other scientific societies has shown that a poster presentation, while more demanding of the author, can provide a superb opportunity for comprehensive discussions of research results. Hence, most sections of the Union will feature one or more poster sessions, and individual papers, if deemed suitable for this type of presentation, may be assigned to one of these sessions.

Presenters of poster papers are reminded that a poster exhibit requires careful preparation. Figures and text will be scrutinized in detail, and authors must be prepared to discuss the contents of their papers in depth. Under these conditions, well-prepared figures and concise logical text are essential.

For actual size, see *Eos*, p. 1199, November 30, 1982.

Sample Abstract

11.8cm

Technique for the Preparation of Abstracts

F. R. S. T. AUTHOR (School of Oceanography, Hydro University, Watertown, Mass. 02172)
S. C. N. D. AUTHOR (USGS, Woods Hole, Mass. 02543)
(Sponsor: I. C. Alvin)

Follow this example in typing the abstract. The printing plates will be prepared by photographing the abstracts exactly as they are received, except that abstracts exceeding the maximum length (18 cm) or width (11.8 cm) will be cut to conform.

Use a good typewriter with a ribbon in good condition. A carbon ribbon gives the best results. Please use type of about this size. Use 12 pitch. There will be a reduction of 50% for the printed abstract volume.

Follow these guidelines:
(1) Type title in capital and lower case letters except where all capitals are standard. Underscore entire title.
(2) Leave one line blank after title.
(3) Type names of authors in all capital letters, with affiliation and address in capital and lower case letters. Do not leave blank lines between authors.
(4) Underscore the name of author who will present paper.
(5) If no author is an AGU member, type sponsor's name in capital and lower case letters.
(6) Leave one blank line after author block.
(7) Neatly drawn in symbols or Greek letters are acceptable. Use India ink.
(8) Use SI units.

18 cm

NOTE: There are no special forms distributed for typing abstracts. You may trace this form in nonreproducible ink. Please leave at least 3 cm between top edge of paper and abstract title. Type abstract as close as possible to left edge of paper.

Submittal Information
(See explanation)

1. Spring Meeting
2. AUTH052536 or ALVI012548 (Sponsor)
3. (a). Corresponding address: S.C.N.D. Author MS 123 USGS Woods Hole, MA 02543
(b). Telephone number 617-548-1234
4. O (Oceanography)
5. Special Session: Deep-Sea Drilling (or none)
6. P (Poster)
7. 10% at Midwest Meeting
8. (a). Hydro Univ. Accounting Dept. Admin. Bldg. Watertown, MA 02172
(b). P.O. #5684739
(c). Student rate applicable
(d). If prepaid enter amount enclosed. (P.O.'s requiring invoicing are not eligible for discount rate)
9. C (Contributed)

Abstract Deadline: March 9
Mail original and two copies to Spring Meeting
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Program Committee

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Geomagnetism and Paleomagnetism (GP) Patrick T. Taylor, NASA/GSFC
Hydrology (H) John R. Ritter, USGS
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SPR Cosmic Rays and Solar and Interplanetary Physics (SS/SC) Miriam A. Forman, SUNY
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Scholarship Assistance for Minority Students in Earth, Space, and Marine Science 1983–1984

The American Geophysical Union is once again pleased to participate in the American Geological Institute's Minority Scholarship Assistance Program. Approximately 70 awards from $500–$1500 are expected to be awarded for this term.

Eligible candidates are:
- Graduate or undergraduate students with good academic records;
- Enrolled in, or applying to, an accredited institution to study earth, space, or marine science;
- Black, Native American, or Hispanic students who are U.S. citizens

For a flyer for your student, call or write to:
Member Programs · American Geophysical Union · 2000 Florida Ave., N.W. · Washington, D.C. 20009 · (202) 462-6903 or 800-424-2488 outside the Washington, D.C. area

For applications, call or write:
Don Diego Gonzalez · Sandia Laboratories · P.O. Box 5800 · Organization 4731 · Albuquerque, NM 87115 (505) 844-8849

Application Deadline February 1, 1983

Special Sessions

Atmospheric Sciences (A)
El Chichón—The Stratospheric Cloud and Its Effects
New Observing Systems for Weather Prediction
Ocean-Atmosphere Climate Interaction in the Pacific (cosponsored by Oceanography)

Geodesy (G)
Earth Rotation and Orientation: Results
Solid Earth and Ocean Tides
Detection and Interpretation of Crustal Movement

Geomagnetism and Paleomagnetism (GP)
Magsat Studies—Secular Variation, Main Field Modeling, and External Fields (cosponsored by SPR-Magnetospheric Physics)
Geological Interpretation of Long-Wavelength Magnetic Anomalies
Paleomagnetic-Stratigraphic Results From DSDP Hydraulic-Piston-Coring Program
Detailed Nature of Magnetic-Field Reversals
Magnetostratigraphy of the Late Cretaceous–Early Tertiary Boundary

Hydrology (H)
Groundwater Flow and Fractured Rocks
International Urban Hydrology
National Urban Runoff Program
Remote Sensing and Evapotranspiration
Canceled: Orinoco River

Oceanography (O)
Absolute Sea Surface Temperature Measurements From Satellites
Gulf of Maine and Georges Bank
Coastal Boundary Layer of the Texas-Louisiana Shelf
Physical Oceanography of the Gulf of Mexico and the Yucatan Straits
Topographic Influences on Current Variability in the Western North Atlantic
Large-Scale, Low-Frequency Variability of the North Atlantic
Equatorial Dynamics
Oceanography of Straits
Oceanography of the Norwegian-Greenland Sea
Response of the Mixed Layer to Atmospheric Forcing
Spaceborne SAR: Oceanographic Applications and Interpretations
Investigations of Oceanic Processes Using Visible Imagery
Results From STACS
Tides
Paleooceanography
Physical/Geological Characteristics of Nearshore Suspended Sediments
Sedimentary Processes in Submarine Canyons
Marine Geology
Marine Sediments
Trace-Element Equilibria/Disequilibria
Comparative Estimates of Chemical Fluxes Across the Sediment-Water Interface
Experimental Estuarine Geochemistry
Reactivity of Pollutants in Seawater
Marine Chemistry
Ocean-Atmosphere Climatic Interactions in the Pacific (cosponsored by Atmospheric Sciences)
Cosmic Ray Nuclides (cosponsored by Atmospheric Sciences; Geomagnetism and Paleomagnetism; Hydrology; SPR-Solar and Interplanetary Physics; SPR-Cosmic Rays; and Volcanology, Geochemistry, and Petrology)

Planetology (P)
Achondritic Meteorites from the Moon and Mars?

Seismology (S)
*Seismicity and Volcanism: Active, Dormant, Inferred (cosponsored by Volcanology, Geochemistry, and Petrology)

SPR-Aeronomy (SA)
Incoherent Scatter Radar Studies of the Ionosphere and Atmosphere
*Atmospheric Electrical Environment (cosponsored by Atmospheric Sciences)

SPR-Cosmic Rays (SC)
Application of Cosmic Ray–Produced Nuclides in Geophysics (cosponsored by Atmospheric Sciences; Geomagnetism and Paleomagnetism; Hydrology; Oceanography; and Volcanology, Geochemistry, and Petrology)

SPR-Magnetospheric Physics (SM)
Numerical Simulation of Space Plasmas (oral and poster sessions)
Waves, Instabilities, and Turbulence in Space Plasmas (poster session)
Aurora and Substorms (poster session)
Magnetospheric Currents and Fields (poster session)
*Geomagnetic Tail and Boundary Layer
*Coordinated Data Analysis: CDAW-6 (oral and poster sessions)
Special Call for Poster Papers on All Subjects

SPR-Solar and Interplanetary Physics (SS)
MHD Turbulence in Space
Solar Seismology

Tectonophysics (T)
*Geochemical Heterogeneities in the Mantle: Implications on Mantle Convection (cosponsored by Volcanology, Geochemistry, and Petrology)

Volcanology, Geochemistry, and Petrology (V)
Chemical and Isotope Constraints on Andean Magmatism

*Additional special session

Session Highlights

SPR-Aeronomy (SA)

Atmospheric Electrical Environment. An all-invited session that will review lightning, cloud, and thunderstorm electricity and global and regional electrical processes. A contributed session on similar topics will also be scheduled (cosponsored by Atmospheric Sciences).

SPR-Cosmic Rays (SC)

Applications of Cosmic Ray–Produced Nuclides in Geophysics. This special session will focus on problems that can be addressed by measuring the amounts of cosmic ray–produced nuclides in various materials. Topics will include particulate transport in the atmosphere and oceans, the recycling of pelagic sediments, groundwater circulation, the relation between cosmogenic nuclides and climate, and the accumulation rates and ages of sedimentary materials and ice. For further information write or telephone Miriam Forman, Department of Earth and Space Sciences, State University of New York, Stony Brook, NY 11794 (telephone: 516-246-8428), or Gregory Herzog, Department of Chemistry, Douglass College, Rutgers University, New Brunswick, NJ 08903. (Cosponsored by Atmospheric Sciences; Geomagnetism and Paleomagnetism; Hydrology; Oceanography; and Volcanology, Geochemistry, and Petrology.)

Tectonophysics (T)

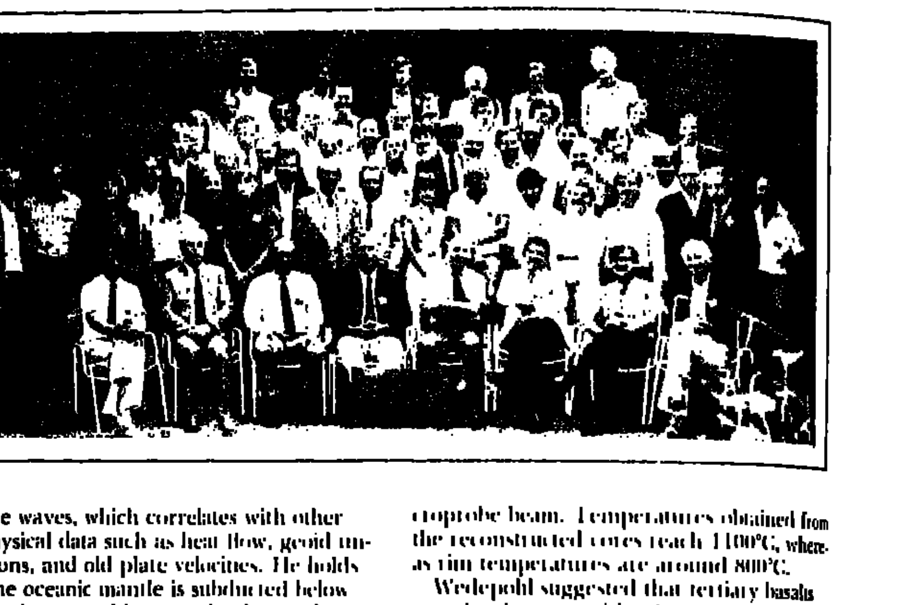
Geochemical Heterogeneities in the Mantle: Implications on Mantle Convection. This session deals with the definition and possible causes of isotopic and geochemical heterogeneities of the oceanic crust and related upper mantle and the constraints these may provide on hotspot provinces convection and flow patterns in the mantle. Organizers: H. Bougault, S. Cande, J.-G. Schilling, and D. Turcotte.

Volcanology, Geochemistry, and Petrology (V)

Chemical and Isotopic Constraints on Andean Magmatism. Presentations of petrologic and geochemical evidence bearing on relative roles of continental crust, mantle, and subducted slab in the petrogenesis of the plutonic and volcanic rocks of the Andes. For further information contact the convenors: Barbara Barreiro, Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Road, Washington, DC 20015 (telephone: 202-966-0863) and Russel S. Harmon, Department of Geological Sciences, Southern Methodist University, Dallas, TX 75275 (telephone: 214-962-2750).

Solubility and Transport Properties of Water in Silicate Melts. Discussions will include water contents in magmas, water solubility models, solubility and spectroscopic data on hydrous glasses and melts, effects of dissolved volatiles on physical properties of melts, and water diffusion in melts and glasses. Further information may be obtained from the convenors: P. McMillan, Department of Chemistry, Arizona State University, Tempe, AZ 85287 (telephone: 602-965-5081) and E. Stoper, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125 (telephone: 213-356-6504).

Geochemical Heterogeneities in the Mantle—Implications for Mantle Convection (cosponsored by Tectonophysics). Isotopic, geochemical, and geophysical heterogeneities of the oceanic crust and related upper mantle and the constraints these may provide on hotspot provinces, convection, and flow patterns in the mantle. Results from IPOD Leg 82 in the North Atlantic will be included. Further information is available from the convenors: S. C. Cande, Lamont-Doherty Geological Observatory, Palisades, NY 10964 (telephone: 914-359-2900); H. Bougault and J. G. Schilling, School of Oceanography, University of Rhode Island, Providence, RI 02908 (telephone: 401-792-6248), and D. L. Turcotte, Department of Geological Sciences, Cornell University, Ithaca, NY 14863 (telephone: 607-256-5267).



Meeting Report

Alfred Wegener Conference

From August 28–31, 1982, the Alfred Wegener-Stiftung held its 1st Alfred Wegener Conference on 'Geophysical, Geochemical and Petrological Evidence on Deformation and Composition of the Continental Subcrustal Lithosphere' at Seeheim/F.R. Germany. It was convened by K. Fuchs (University of Karlsruhe) and H. Wänke (Max-Planck-Institut Mainz).

The main results and questions from this conference may be summarized as follows: Geophysical, petrological, and geochemical models of the earth's continental lithosphere have been refined recently so far that they are no longer independent of one another. From an analysis of xenoliths the compositions proposed for this part of the earth were confronted with seismic velocities measured in situ at depth. Both observations are not compatible unless seismic anisotropy is present in the upper mantle. Triaxial anisotropy was also required in the asthenosphere from a world-wide inversion of surface wave data. Seismic anisotropy was recognized as a possible tracer of mantle convection. Whether it signifies a paleomotion or is generated by recent flow patterns depends on a number of material parameters that require future research in the field, in the laboratory, and in numerical modeling, e.g., experiments on stress relations at low strain rates, on seismic velocities and their partial derivatives at seismic frequencies under upper-mantle conditions, and on field experiments to map anisotropy in the mantle and lower crust. The conference showed that geophysical, petrological, and geochemical models can and should be integrated, since they offer mutual constraints.

Sessions were held on composition and structure of the earth's mantle, probing the continental subcrustal lithosphere for composition and physical properties, seismic anisotropy of the oceanic and the continental upper mantle, deformation at the crust-mantle boundary, and upper mantle stress and strain. Thirty-six oral papers and five poster papers were presented. Sixty-one scientists attended from Australia, Austria, Canada, China, F.R. Germany, France, Japan, Switzerland, United Kingdom, and United States of America.

Ringwood* investigated mechanical behavior and phase and density changes in subduction zones and surrounding pyrolite mantle. The lower, ductile layer of the downgoing slab consists of slightly depleted pyrolite which is stripped off the slab and mixed with surrounding mantle, providing a source for midocean ridge basalts. The upper, cool, brittle layers of basalt and harzburgite undergo a significantly different series of phase transformations and therefore are denser in comparison with surrounding mantle down to 600–650 km. At these depths, harzburgite becomes less dense than pyrolite, former basalt remains denser. This causes a nonuniform stress distribution, and the slab begins to buckle and accrete to large, cool 'megaliths.' Conductive thermal equilibration (1–2 b.y.) causes partial melting of the former basalts (the restites sink into the lower mantle) and contamination of the harzburgites. This fertile harzburgite can rise diapirically and be responsible for the hot-spot volcanism of oceanic islands or the updoming, rifting, and connected volcanism in continents.

D. L. Anderson discussed the petrological model of the mantle from the seismological PREM model. He stressed the presence of transverse isotropy in the asthenospheric low-velocity zone decreasing with depth above the Lehmann discontinuity, with high velocities in the horizontal and low velocities in the vertical direction. There is clear evidence for lateral heterogeneities from multicoverage of surface waves, which correlates with other geophysical data such as heat flow, geoid undulations, and old plate velocities. He holds that the oceanic mantle is subducted below the continents and is not to be dropped to the core. The mantle above 220 km is enriched in olivine. The presence of eclogit is required in the transition zone.

Hofmann pointed out a major problem in basalt genesis models derived from isotopic constraints. Nd and Sr isotopes require highly depleted (in incompatible elements) sources for midocean ridge basalts and less to nondepleted reservoirs for oceanic island basalts. Pb isotopes require enriched (in incompatible elements) reservoirs for all these basalts. Currently, two major models are proposed to solve this problem: *(a)* mantle depletion and mantle metasomatic events where the timing of the processes and the evidence from ultramafic inclusions (mantle material) are still not very clear; *(b)* recycling of oceanic crust into the mantle, whereby mixing with depleted and nondepleted mantle material may cause the whole spectrum of basaltic types.

Wänke pointed out that studies on lherzolite nodules revealed the existence of primitive reservoirs in the upper mantle, having almost chondritic abundance ratios of all 56 refractory lithophile elements except for the most incompatible ones and being almost identical to pyrolite in its major element composition. This finding speaks against large-scale fractionation of the mantle as a whole.

Spohn pointed out difficulties in numerically modeled mantle convection where the lower mantle convects separately from the upper mantle.

Allegre demonstrated the use of natural isotropic tracers (Sr, Nd, Pb, He) to study the evolution of the mantle. Most of the mantle was depleted. Two processes are possible: *(a)* depletion of the mantle by extraction of basalts (This would effect the major and trace elements in the mantle, and a large mass exchange between mantle and crust must be postulated.); *(b)* depletion of the mantle by extraction of granites. Mainly, tracer elements of the mantle are affected. Major arguments for this are the isotropic initials of archean granites close to the isotopic evolution of the mantle and the complementary tracer-element characteristics from granites to the depleted reservoir.

He reported 'two-point Sr isochrones' from garnetlherzolite nodules as evidence for accretion of the continental lithosphere from 2.5 b.y. on. The older accreted lithosphere is less depleted than the younger and deeper segments.

Jordan provided evidence from P- and PKP-travel time anomalies that downgoing slabs continue to depths greater than 650 km, possibly down to 900–1000 km. This contradicts Ringwood's model. Jordan reviewed his model of the roots of the continents that are depleted in basaltic constituents and are therefore lighter, with higher seismic velocities, than the oceanic mantle. The lighter densities of the continental mantle are offset by cooler temperatures. Because of its refractory nature, part of the continental mantle becomes a stable geochemical reservoir with widespread metasomatism that has been impregnated by large-ion lithophile elements fluxing from the deep mantle, causing high heat production and contributing significantly to the surface heat flux. According to Nicolas, the oceanic and the continental mantle show similar depletions to a depth of 80 km, below 80 km the continental mantle is more depleted.

Kurat produced possible evidence for mantle metasomatism from two different rock types: *(a)* A volcanic rock from Siberia (meimechite—similar to kimberlites in major elements) has a high content of incompatible elements (especially light rare earths) together with a high content of compatible elements (especially Ni). This suggests a source formerly depleted by a partial melting event and later enriched by a metasomatizing fluid. *(b)* Hornblende-bearing lherzolites within H_2O-free spinel and plagioclase lherzolites and harzburgites from Zabargad Island in the Red Sea are considered to be the result of upper-mantle metasomatism.

Seck discussed the upper-mantle cooling history in deformed porphyroclastic spinel peridotites from the West Eifel. They contain large (up to 8 mm) orthopyroxenes with exsolved clinopyroxenes and spinels in their center. Original core compositions (before exsolution) were obtained with a defocused microprobe beam. Temperatures obtained from the reconstructed cores reach 1100°C, whereas rim temperatures are around 800°C.

Wedepohl suggested that tertiary basalts (ranging in composition from quartz tholeiites to olivine melilitites) from the lower Saxony, north of Vogelsberg, are derived by partial melting of spinel lherzolite formerly depleted in basaltic component and later enriched in incompatible elements. Evidence is the refractory nature of the ultramafic inclusions (74 vol% olivine), their chemistry, the high contents of incompatible elements in the basalts, and the behavior of the heavy rare earth elements in these rocks.

Dawson distinguished between two types of metasomatism in mantle-derived ultramafic nodules: *(a)* patent metasomatism where textural evidence shows that primary phases are replaced by later hydrous phases (amphibole and/or phlogopite) (This type of metasomatism seems to mirror the composition of the host igneous rocks.); *(b)* cryptic metasomatism, which is less obvious and is only recognized by the fact that ultramafic nodules depleted in basaltic components (i.e., in CaO, Al_2O_3, Na_2O, . . .) are enriched in incompatible elements such as K, Pb, U, and light rare earth elements. This enrichment appears to be quite old (1.5–2 b.y.), while the patent metasomatism appears to be a precursor to volcanic activity.

St. Mueller discussed the topography of the lithosphere-asthenosphere boundary in Europe, which is determined from a regionalization of surface waves. Features at depth are not always identical with surface features, e.g., the Rhinegraben extends well into the Alps. Another important phenomenon is the subduction of lithosphere into the mantle below the axis of the Alps. Reviews of deep seismic sounding of the upper mantle on long-range profiles were given by Ansorge, Miller, Prodehl, and Zeng-Rongsheng. From various parts of the world, fine structures and unusually high velocities were reported.

The session on anisotropy in the mantle was opened by D. L. Anderson, who presented evidence for anisotropy from a large set of travel time residuals. In the analysis of surface waves the direction of the fast axis was allowed to vary in correspondence with downgoing at trenches, upgoing at ridges, and horizontal at oceanic basins. For Rayleigh wave periods of 150 s the continents do not show up. Instead, there is a correlation with geoid undulations; lows have maximum seismic velocities, and highest heat flow correlates with slow regions. For 250 s there is no correlation with the geoid. The type of anisotropy seems to be a function of age of the oceanic lithosphere. An anisotropy inversion thins the oceanic lithosphere that is in better agreement with seamount loading.

Shimamura reported latest results from ocean-bottom seismology in the Pacific ocean near Japan. There are now several profiles with a length of 1200 km covering various azimuths. At a depth between 50 and 100 km the velocities change with azimuth between 7.6 and 8.8 km/s. Since the fast direction is perpendicular to the magnetic lineations, but the plate moves obliquely to them, it is concluded that the deeper oceanic lithosphere remembers the original direction of spreading for at least 40 m.y., i.e., the observed anisotropy is a frozen-in feature. A future problem is to obtain higher resolution in the anisotropy depth distribution.

Jacoby reported on lithosphere-asthenosphere structure from group velocity analysis of Rayleigh waves parallel to the Island-Reykjanes ridge, showing the thickening of the lithosphere with age.

A special discussion meeting on the seismological differences of the oceanic and continental lithosphere was arranged in which Jordan and D. L. Anderson served as key speakers. While there was consent about heterogeneities above 200 km, there was disagreement about continental roots below 200 km (Jordan), which Anderson could not see. The discussion merged into a petrological argument on the presence (Anderson) and absence (Ringwood) of eclogite above the 650-km discontinuity.

The session on anisotropy in the continental subcrustal lithosphere started with a critical review by Jackson of the work done in Australia on anisotropy at the 200-km discontinuity. The main evidence comes from observed seismic velocities exceeding those predicted from petrological models of the mantle. To verify the presence of anisotropy, Jackson asked not only for seismic observations in other azimuths but for refined determinations of elastic constants at seismic frequencies and relevant P,T conditions. Fuchs compared unusually high seismic velocities in southern Germany with velocities derived from a suit of petrological models derived from local xenoliths. He concluded that only an anisotropy in the mantle increasing with depth is compatible with both seismic and petrological observations. While the mantle immediately below the crust-mantle boundary comes close to a fertile composition, it becomes strongly depleted already within the first 10 km. The alignment of the olivine crystals is compatible with the orientation of the present crustal shear stress field. Nicolas discussed the various mechanisms for the formation of preferred orientation of olivine. Thirty percent strain seems sufficient to produce anisotropy. The fabric axis will always correlate with the flow orientation. He reported on fabrics experiments on synthetic rocks. Harzburgite seems to develop larger anisotropy than peridotite. It appears that depleted materials have a lower viscosity than undepleted, or that the flow will concentrate in harzburgite. Hirn reported on new deep-seismic sounding results from Tibet. P_n velocities of 8.6 km/s were observed on reversed E-W profiles at a depth of about 70 km, corresponding to 8.7 km/s at surface temperature-pressure conditions. This fast velocity was recorded perpendicular to the motion of India. Prodehl provided a review of anisotropy analysis for the continental mantle and presented a comprehensive collection of P velocity–depth distributions for the mantle with the typical fine structure and increased velocity values obtained by deep-seismic sounding on long-range profiles.

In the session on deformation at the crust-mantle boundary, Christensen reported on deformation and associated anisotropy near the oceanic and continental Moho from field experiments at ophiolites in Oman and other places. They were supported by laboratory studies of the anisotropy in rock samples. Granulites of the lower crust are also likely candidates for anisotropy by preferred orientation of plagioclase and anorthosite.

Oliver presented evidence for deep-reaching thrust zones from COCORP deep reflection work and argued for a worldwide effort to illuminate deep structures by continuous reflection profiling. In deep reflection work the Moho does not seem to be the same discontinuity everywhere. Behr discussed nape tectonics in the Variscian mountain system with models of stretching of the lower crust and decoupling of lower crust from upper mantle by instrusion of asthenolites. A step in the Moho in northern Scotland, and lateral heterogeneities in the structure of the subcrustal lithosphere deduced from refraction seismic experiments, were presented by Faber. Giese argued for an overthrust geology reaching into the upper mantle supported by refraction seismic data with examples from the USSR, Southern Italy, the Apennines, and the Alps.

The last session on upper-mantle stress and strain was devoted to dynamic modeling and state of temperature of the continental mantle. Froidevaux modeled the dynamics of mass heterogeneities and lithosphere deformation. The spreading of continents and especially of mountains is prevented by high density roots that set continents and mountains into compression. The compressive stress regime in mountains may reverse if the dense root becomes detached. The thermal state of the lithosphere was discussed by Chapman. Physical parameters and processes of the lithosphere are governed by the temperature field. He presented evidence for an increased average global heat flow value of 80 m W/m² if convection contribution of young oceanic lithosphere is taken into account, and he discussed geotherms for static, dynamic steady state, and transient states. There followed short contributions by Jaupart on thermal contrast of the thickness of the lithosphere; Spohn on lithosphere thinning caused by convective instability; Jacoby on convection models with two-dimensional viscosity distributions (plate motions are highly dependent on decoupling); Neugebauer on numerical modeling of anisotropy and shear heating (he sees higher shear heating and related anisotropy developing in the root zones). Finally, Reigber reviewed the accuracy of the measurement of plate kinematic parameters from laser satellite interferometry with emphasis on the station network planned for the Mediterranean. A precision of 5 cm is foreseen in 5 years.

K. Fuchs is with the Geophysical Institute of Karlsruhe University, Karlsruhe, Fed. Rep. Germany. H. Wänke is with the Max-Planck Institute for Chemistry, Department of Cosmochemistry, Mainz, Fed. Rep. Germany.

*A list of references to the various contributions is available on request from K. Fuchs, Geophysical Institute, University, Hertzstrasse 16, D-7500 Karlsruhe 21, F.R. Germany.

List of Participants

C. J. Allegre, Paris; E. Althaus, Karlsruhe; D. L. Anderson, Pasadena; J. Ansorge, Zürich; H. J. Behr, Göttingen; P. Blümling, Karlsruhe; G. Brey, Mainz; P. Burek, Mainz; D. S. Chapman, Salt Lake City; N. Christensen, Seattle; H. Closs, Hannover; J. B. Dawson, Sheffield; S. Faber, Erlangen; C. Froidevaux, Orsay; K. Fuchs, Karlsruhe; K. von Gehlen, Frankfurt; P. Giese, Berlin; F. Goerlich, Bonn; Ch. Göpel, Paris; M. Grünewald, Karlsruhe; A. Haas, Karlsruhe; Z. Hajnal, Saskatoon; H. Häge, Karlsruhe; M. Hauck, Karlsruhe; A. Hirn, Paris; A. W. Hofmann, Mainz; P. Hubral, Hannover; I. Jackson, Canberra; W. R. Jacoby, Frankfurt; E. Jagoutz, Mainz; C. Jaupart, Paris; Th. H. Jordan, La Jolla; G. Kurat, Wien; G. Lensch, Saarbrücken; K. Mengel, Göttingen; H. Miller, München; St. Mueller, Zürich; W. Müller, Darmstadt; H.-J. Neugebauer, Clausthal-Zellerfeld; A. Nicolas, Nantes; J. Oliver, Ithaca; H. Palme, Mainz; C. Prodehl, Karlsruhe; H. Puchelt, Karlsruhe; Ch. Reigber, München; C.-D. Reuther, Karlsruhe; A. E. Ringwood, Canberra; Rongsheng-Zeng, Beijing; M. Rosenhauer, Frankfurt; G. Sattel, Karlsruhe; H. V. Schmincke, Bochum; H. Seck, Köln; H. Shimamura, Sapporo; H. Siemes, Aachen; T. Spohn, Frankfurt; R. Stangl, Karlsruhe; H. Wänke, Mainz; J. Walther, Karlsruhe; K. H. Wedepohl, Göttingen; H. Wilhelm, Karlsruhe; G. Wörner, Bochum.

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Aeronomy

0410 Absorption and scattering of radiation (particles)
MEASUREMENT OF STRATOSPHERIC AEROSOL NEAR SANRIKU (39°N, 142°E) IN JAPAN ON MAY 31, 1979
A. Matsuzaki (The Institute of Space and Astronautical Science, Komaba, Meguro, Tokyo 153, Japan), Y. Nakamura, T. Itoh
[illegible]
J. Geophys. Res., Green, Paper 2C1936

0430 Composition
SIMULTANEOUS MEASUREMENTS OF VERTICAL DISTRIBUTIONS OF STRATOSPHERIC NO_2 AND O_3 AT DIFFERENT PERIODS OF THE NIGHT
F. Pigaud (Station Scientifique du Val Joyeux, F-78450 Villepreux), J.P. Naudet and D. Huguenin
[illegible]
J. Geophys. Res., Green, Paper 2C1762

0430 Composition (Atomic or Molecular)
MEASUREMENTS OF METASTABLE [illegible] EMISSION IN THE TWILIGHT THERMOSPHERE
D. G. Torr (Center for Atmospheric and Space Sciences, Utah State University, UMC 41, Logan, Utah 84322), Wadad A. Abdou, M. R. Torr, R. G. Burnside, and J. W. Meriwether, Jr.
[illegible]

[illegible] Upper limits of 5 x 10^-12 [illegible]
J. Geophys. Res., Blue, Paper 2A1923

0430 Aeronomy (Molecular Composition)
FIRST INFRARED MEASUREMENT OF ATMOSPHERIC NO_2 FROM THE GROUND
L. Camy-Peyret (Physique Moléculaire et Optique Atmosphérique, CNRS, Bâtiment 221, Campus d'Orsay, 91405 Orsay Cedex, France) [illegible]
[illegible]
Geophys. Res. Lett., Paper 2L1906

0450 Pressure, density, and temperature
INITIAL TESTS OF AN INDEX BASED ON AL VALUES FOR MODELING MAGNETIC STORM RELATED PERTURBATIONS OF THE THERMOSPHERE
J. S. Nisbet, C. Stehle and E. Bleuler (Electrical Engineering Department, Ionosphere Research Laboratory, University Park, Pennsylvania, 16802)
[illegible]
J. Geophys. Res., Blue, Paper 2A1983

Geochemistry

1410 Chemistry of the atmosphere
THE CONTRIBUTION OF VOLCANOES TO THE GLOBAL ATMOSPHERIC SULFUR BUDGET
H. Berresheim (Center for Environmental Protection, University of Frankfurt, Robert-Mayer-Str. 11, D-6000 Frankfurt/M., FRG), and W. Jaeschke
[illegible]
J. Geophys. Res., Green, Paper 2C1913

1430 Geochemistry (Chemistry of bodies of water)
ISOTOPE GEOCHEMISTRY OF THE AMAZON BASIN: A RECONNAISSANCE
A. Longinelli (Instituto di Mineralogia, Petrografia e Geochimica, University of Palermo, Palermo, Italy) and [illegible]
[illegible]
J. Geophys. Res., Green, Paper 2C1542

1499 General (Infrared Properties)
ABSOLUTE BAND STRENGTHS OF HALOCARBONS F-11 AND F-12 IN THE 8-16 μm REGION
R. H. Kagann, J. W. Elkins (Gas and Particulate Science Division, National Bureau of Standards, Washington, DC 20234) and R. L. Sams
[illegible]
J. Geophys. Res., Green, Paper 2C1781

Electromagnetics

0799 Miscellaneous (Radio Loss in Forests)
RADIO LOSS IN FORESTS USING A MODEL WITH FOUR LAYERED MEDIA
G. P. dos S. Cavalcante, D. A. Rogers and A. J. Giarola (Electrical Engineering Department, FEC, UNICAMP, P. O. Box 1170, 13100 Campinas, SP, Brazil)
A model with four layered media is developed for the calculation of the radio loss in forests. In this model two lossy dielectric layers placed over a conducting flat earth are used to represent the crown and the trunk of the trees. Dyadic Green's functions in their eigenfunction expansion forms are used to analyze this model and the electromagnetic fields are obtained from these functions. The theoretical results of the radio loss for vertical and horizontal radiating dipoles and for typical forests agree with the available experimental data. For this comparison the parameters for the layer representing the crown of the trees were estimated. (Radio loss, forests, four layered media)
Rad. Sci., Paper 2S1812